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# SOME RECENT PROBLEMS IN STORAGE BATTERY ENGINEERING.

BY

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(*Presented at the meeting of the Electrical Section, held Thursday, October 6th, 1910.*)

[The use of the storage battery in modern electric generating plants is given consideration in this paper. Mention is made of its application in various power plants and results of efficiency are presented.]

IN presenting this paper to-night, my object has been to touch upon some of the most important developments which have recently been made in storage battery application and engineering.

The wonderful increase in the use of electrical energy for industrial purposes has developed the centralization of the generating station (on account of the increased capacity necessary), the distribution over large areas being effected by means of high tension lines and substations.

The increase in the size of the generating station necessarily alters the method of storage battery application to such systems. They are no longer used to any extent to even up the load on the generating machinery, but are used for emergency or "stand-by"

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service in substations and to carry peaks of short duration. In systems generating current at one or more stations and distributing it over wide areas there must of necessity be many chances of interruption of service due in the majority of cases to causes outside the control of the Company operating the system. By this I mean accidents to transmission lines through excavations, building operations, etc. These interruptions are usually of short duration but may affect the whole system.

The New York Edison Co., one of the early pioneers in storage battery application, realized the value of storage batteries for this purpose on their system and attacked the problem in a radical and novel way.

A little over two years ago they asked me to meet their engineers and discuss the problem of furnishing storage batteries for emergency or "stand-by" service having the following characteristics:

Maximum output of energy for short periods.

Minimum first cost and up-keep.

Minimum space requirements and weight.

Last, but most important from the manufacturing and commercial side, these batteries need only have a life of about three hundred discharges, as the estimated number of discharges per annum in this service would not exceed twenty or thirty.

The company with which I am connected undertook to solve this problem with the result that in 1908 we installed for the New York Edison Co. in their Thirty-ninth St. Substation a battery of this type.

The plates used were a development of the well-known Exide plate and I will give you some comparative figures between this type of battery and the standard Manchester plate which the Edison Companies have been using for the past twelve years.

Fig. 1 exhibits the results taken from a Standard Manchester cell containing sixty-nine H-plates and the same cell filled with Exide H-plates. The Exide plates being thinner, 111 can be installed in a tank of the 69 H-Manchester type.

Summarizing these figures it will be seen that the new type of plate has a much greater output at high rates, and will maintain same for a longer period of time with a higher terminal voltage. Take, for example, the discharge at four times the hour rate. The Exide plates give nearly twice the output of the old plate,

for double the time, and with a higher terminal voltage. For the same space occupied, with only 15 per cent. increase in weight, the output of the new plate will vary from about two to four times that of the old plate, according to the rate of discharge taken as a basis of comparison.

The question of floor space is a most important one in sub-station equipment, and a reduction in battery space required means a saving both in real estate and cost of building. Bat-

FIG. 1.

MANCHESTER

WEIGHT_ _ _ _ _ _ _ 5800 POUNDS PER CELL COMPLETE

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4850 | Amp. | for | 1 | Hour | down to | 1.6 | Volts | per | Cell. |
| 9700 | " | " | 15 | Min. | " | 1.4 | " | " | " |
| 14500 | " | " | 6.5 | " | " | 1.2 | " | " | " |
| 19400 | " | " | 3 | " | " | 1 | " | " | " |

EXIDE

WEIGHT_ _ _ _ _ _ _ 6600 POUNDS PER CELL COMPLETE.

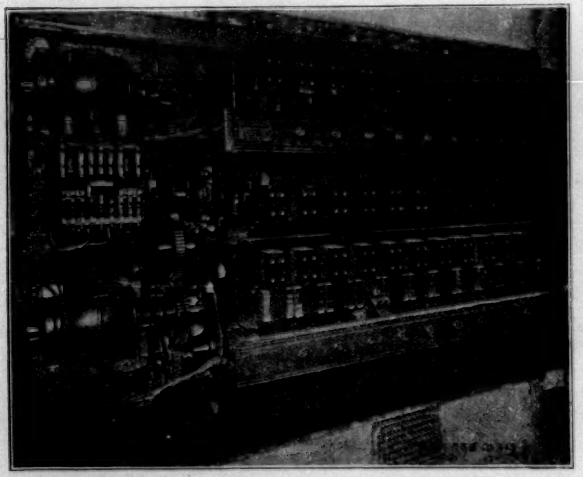
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 3166 | Amp. | for | 1 | Hour | down to | 1.64 | Volts | per | Cell. |
| 18333 | " | " | 21 | Min. | " | 1.48 | " | " | " |
| 27500 | " | " | 10 | " | " | 1.32 | " | " | " |
| 36666 | " | " | 6 | " | " | 1.16 | " | " | " |

teries used for this emergency service are not called upon to discharge as many kilowatt-hours per annum as in the former service, and consequently will remain in operation for a much longer time without needing renewals. This makes a material difference in the cost of maintenance. This type of cell will, I believe, open up a more extensive field for storage batteries in connection with large distributing systems of electrical energy, on account of the greater output obtainable, which places the cost per kilowatt upon a different basis, and makes a most attractive proposition. The use of this battery is not necessarily restricted

to large systems, but will give equally satisfactory results in the case of smaller plants.

The results obtained from the first battery of this type installed for the New York Edison Co. were so satisfactory that since that battery was installed, ten large batteries have been purchased by the larger Edison Companies. One battery in particular I would like to say a few words about on account of its size. It is installed in the Sixteenth Street Substation of the

FIG. 2.



New York Edison Co. It consists of 150 cells, each containing 131 H-Exide plates. The output at various rates is as follows:

10790 amperes for 1 hour.
21580 amperes for 21 minutes.
32370 amperes for 10 minutes.
43160 amperes for 6 minutes.

The use of the emergency or "stand-by" batteries with these high rates of discharge made it necessary to develop end-cell switches which could carry such enormous currents and enable

additional cells to be cut in during the discharge as the voltage of the cells dropped.

Fig. 2 shows two of the four end-cell switches installed with the battery I just referred to for the New York Edison Co. They have twelve points to each switch, seventeen end-cells being connected to them as follows:

9 points with one cell between each point.

3 points with three cells between each point.

FIG. 3.

BATTERIES ON EDISON SYSTEMS

KILOWATT HOUR CAPACITY AT 1 HOUR RATE

| | | | |
|---|---|---|---|
| BOSTON | 7016.44 | 5 | BATTERIES |
| NEW YORK | 32342.00 | 44 | " |
| BROOKLYN | 7174.00 | 11 | " |
| PHILADELPHIA | 2277.60 | 4 | " |
| CHICAGO | 24216.13 | 26 | " |
| OTHER | 41461.39 | 66 | " |
| TOTAL | 114488.00 | 160 | " |

This arrangement gives one cell per point regulation around the floating point so that the battery voltage can always be adjusted to the bus voltage.

These switches have a maximum capacity of 20,000 amperes for short periods, and can be operated from point to point while carrying that current.

Switches of similar type having a maximum capacity for short periods of 40,000 amperes are now being constructed.

Fig. 3 shows the battery capacity in use by the Edison Companies throughout the country. This table is calculated on the

one hour discharge rate capacity, and of course for shorter periods the output is increased.

Only a few of these batteries are the latest Exide type for emergency service, but figuring on the Manchester ratings, the capacity of these batteries for six minutes would be 343,464 kilowatts or the equivalent of 17,000,000 20-watt lamps.

Some figures compiled last spring show the following percentage of battery capacity (figured on the one hour discharge rate) to the maximum direct current peak loads of the following companies:

| | |
|---|---|
| New York Edison | 25 per cent. |
| Chicago Edison | 48 per cent. |
| Brooklyn Edison | 36 per cent. |
| Boston Edison | 36 per cent. |

Before leaving this part of our subject I would like to refer to a new field for storage batteries in connection with purchased power contracts.

The low cost of production of electrical energy, due to the greater capacity of generating stations, enables the consumer, in most cases, to purchase power cheaper than he can produce it, and the question of the relations between manufacturer and consumer has greatly increased in importance. Nearly every consumer will have different conditions both as to load and duration of time during which power is required, and the central station manager is confronted with the problem of marketing his energy so as to give the best net results from a financial stand-point.

Storage batteries must, and do, play a very important part in power contracts of this sort. It is not within the scope of this paper to consider the various forms of power rates or contracts, but I wish to point out the fact that the installation of a storage battery will often turn a customer with a poor load factor into one with a good load factor, to his gain and also to that of the central station. These situations are very numerous, each plant requiring individual investigation to ascertain the best arrangement to adopt to make the customer as profitable as possible, and moreover, they cover all kinds of service, both direct- and alternating-current. The two principal methods of using storage batteries in connection with power contracts are as follows:

*First.*—To relieve the purchased power of frequent fluctuations, thereby improving the load factor and keeping down the maximum demand.

*Second.*—To carry peaks of short duration so that the same improvement of load factor and reduction in maximum demand may be effected.

In many cases that have come under the writer's notice, customers have peaks that exist for only a few months in the year, but by the use of a storage battery a better load factor for the entire year can be maintained. An interesting example of this application is found in the case of a large railway company in Chicago, purchasing power from the Commonwealth Edison Company, with which contract, on account of its important features, you may be familiar.

Probably the most interesting recent development from an engineering stand-point is the regulation by storage batteries of alternating-current generating plants and I will touch on two different applications along these lines.

1. Where generating plant is *A C* but load is *D C*, rotary convertors or motor generators being used to transform the *A C* to *D C*.

2. Where generating plant is *A C* and load is principally *A C* with a small proportion of *D C*.

Illustrating the first application I will refer to the plant of the Otsego & Herkimer Railroad Company, New York. This Company operates an electric railway system in New York State extending from Oneonta to Mohawk, a distance of about 55 miles, with a three-mile spur to Cooperstown and about three miles of track for local service in Oneonta.

The power is generated at two different power houses, one a steam plant at Hartwick, and the other a water-power station on the Susquehanna River at Colliers.

Energy is transmitted from the Water-Power plant to the steam station at 13,000 volts, 3 phase 25 cycles, where it is connected in parallel with the steam station bus; from there it is transmitted over a 13,000 volt 3 phase line to the distant substations.

There are four substations, one at the steam power house, and three distant ones.

The substations are equipped with 300 k.w. 600 volt rotary convertors.

The storage battery and auxiliary apparatus is installed at the steam power house and is so arranged as to regulate on both the water-power and the steam-power generating plants.

For controlling the charge and discharge of the battery a motor-driven booster is installed together with a motor-driven exciter controlled by a carbon regulator. This regulator is operated by an *A C* solenoid connected to the generator circuits in such a way as to respond to small variations of combined load on all of the units which are in operation at any time. The battery with its booster in series is connected directly across the 600 volt *D C* bus in parallel with the rotary convertors which feed the railway circuit at that point. As stated above, however, the operation of the battery is so controlled as to regulate the total load on the system and fluctuations of this total load above or below the average whether originating at the power house substation or at one or more of the others, are handled by the battery which charges from, or discharges into, the *D C* bus at the power house substation to effect this result. Thus, if a heavy increase of load should occur at one of the remote substations the battery will relieve the D C load at the substation where it is located to a sufficient extent to compensate for the increase elsewhere and hold the total load on the system constant. If the increase in load is sufficient the battery may take the entire *D C* load of the convertors at the power house and upon further increase discharge back through these into the *A C* circuits.

Fig. 4 is a load diagram showing the results obtained by the battery operation. The heavy line represents the total generator load while the light line is the total combined load of all the substations. The difference between these two lines showing the battery charge and discharge.

To illustrate the second application of *A C* regulation, I will refer to the plant of the U. S. Steel Co. at Gary, Indiana.

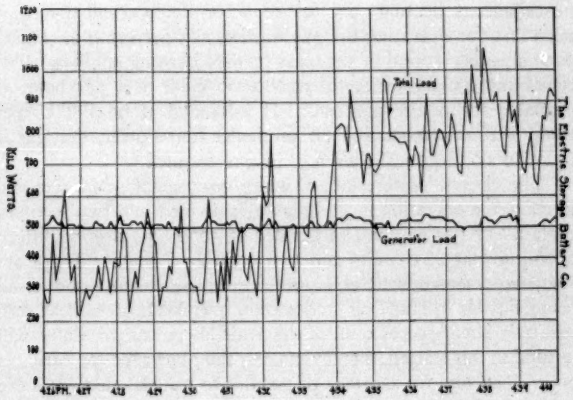
This plant is so unique and interesting that at the risk of repeating to some of those present what they may already know about it, I venture to give some figures illustrating its enormous size and modern features. I was fortunate enough to be closely connected with the engineering details of the power and distribut-

ing plant, and cannot but admire the courage exhibited by those designing the outfit.

The opportunity was presented at Gary to design from the ground up a complete steel plant of a magnitude greater than before attempted and without restrictions imposed by consideration of existing equipment and buildings.

The site of the plant is at the extreme southern end of Lake Michigan, 26 miles from Chicago. It consists of about 10,000 acres which were absolutely uninhabited and undeveloped. The

FIG. 4.




advantages found here were lake transportation, cheap land, and splendid railroad facilities.

The governing feature in the design was economy of operation and to this end the arrangement was so planned as to get the best possible facilities for transporting the material during the various stages of manufacture throughout the entire works. The electric motors were adopted as a source of power wherever they could be applied, namely, to drive ore unloaders, ore bridges, car dumpers, bin-filling cars, scale larries, blast-furnace skips, hot-metal mixers, electric cranes of all sizes and description, open-hearth charging tables, ingot buggies, gas producers, main rolls

of mills, rolling tables, lifting tables, transfers, and a multitude of machines too numerous to mention here.

To add further to the economy, it was decided to use blast-furnace gas in gas engines for driving electric generators to furnish the electric power throughout the plant. The gas from eight blast-furnaces is used for the electric power station. These eight blast-furnaces producing 3600 tons of pig-iron for 24 hours will give a total of 22,450,000 cubic feet of gas per hour: 30 per cent., or 6,750,000 cubic feet, of this gas is used for treating stoves; 7.5 per cent., or 1,700,000 cubic feet, is used under the boilers to furnish steam for spare steam engines, pumps, and miscellaneous heating; 2.5 per cent., or 600,000 cubic feet, is necessary for operating the gas washers; 15 per cent., or 3,400,000 cubic feet is used by the blast-furnace blowing engines. The remaining 45 per cent., or 10,000,000 cubic feet per hour, is available for power purposes. If estimated at 90 B.T.U. per cubic feet and 10,000 B.T.U. per boiler horsepower, this gas is equal to 90,000,000 boiler h.p. in gas engines.

The electric power station, which on account of its size and to make the operation more reliable, is divided into two sections, contains 17 gas engines, each rated at 3000 h.p., driving fifteen 2000-kilowatt *A C* units and two 2000 *D C* units. There are also two 2000-kilowatt *A C* units driven by steam turbines, all being capable of standing 50 per cent. over-load. It will be seen that only about 50 per cent. of the available gas as calculated will be used in this station, thereby making full allowance for furnaces out of blast and for shortage of gas due to troubles that are liable to occur to furnaces during operation.

The gas engines are horizontal twin-tandem double-acting, running at 83⅓ revolutions per minute. The cylinders are 44 inches in diameter with 54-inch stroke. The floor space occupied by each engine and generator is 74 x 39 feet with an approximate weight of 1,700,000 pounds. The steam turbines were installed primarily for use in the construction of the plant and to furnish power for starting up.

The switchboard in this plant is most interesting and contains many special features. Each piece of generating and distributing apparatus in the power station is under the control of the operators stationed at the bench-board in the gallery, re-

mote control apparatus being used even down to the smallest capacities.

The enormous capacity of this plant is perhaps illustrated by the rail mill which has a capacity of 4000 tons of finished rails per 24 hours. It is not only the largest but also the only electrically driven mill in the world, rolling rails direct from the ingot without re-heating. The main rolls of the mill are driven by five induction motors having a combined capacity of 22,000 h.p., made up of three 6000-h.p. and two 2000-h.p. units. Besides these there are the auxiliary motors for operating the tables, transfers, hot saws, etc.

Fig. 5 shows the combined load of the rail mill which it will be noted fluctuates from 4400 to 19,000 h.p., with an average of 12,025 h.p.

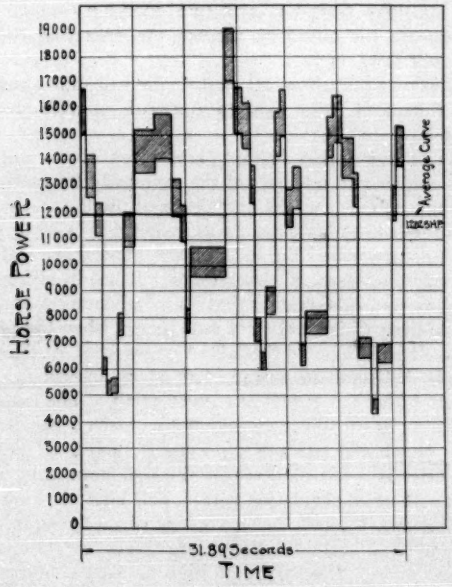
The brief description of this plant given above will readily enable an engineer to understand the extremely fluctuating character of the load and also the magnitude of the fluctuations.

A storage-battery equipment was installed principally to minimize the fluctuations of the load on the generating station and this equipment is unique in many ways. It has been found since the plant has been in operation that many advantages are derived from the battery which were not anticipated when the plant was designed. It will be noted that about 90 per cent. of the generating plant is A C and the storage battery equipment is designed to take care of both *A C* and *D C* fluctuation. The battery consists of two series of chloride accumulators, each series containing 125 cells. Each cell contains 73 Type R plates. The capacity of each series is 4320 amperes at the one hour rate, or 8640 amperes at the usual regulating rate. This latter writing is more or less arbitrary, the cells being capable of discharging momentarily at much higher rates under emergency conditions should the demand arise. Discharges as high as 25,000 amperes have been taken from this battery.

The regulation of the *A C* load and the emergency service in connection with same is the principal function of the battery as well as the most interesting on account of the methods involved. The *A C* service is accomplished by means of two split-pole convertors which are connected between the battery and the *A C* bus, each convertor having a continuous rating of 6800 amperes direct current in either direction, with a voltage range from 225 to 275

volts at the direct-current brushes. The momentary over-load ratings are 10,000 amperes output as a true convertor at 300 volts, or 14,000 amperes input as an inverted convertor at 200 volts. The alternating voltage at the collectorings remaining constant throughout these ranges of direct voltage. The direct current terminals of these convertors are connected directly across

FIG. 5.




the battery without the interposition of any booster, and the variation of direct voltage required to cause the battery to charge and discharge is brought about by varying the distribution of field flux over the pole face. The convertors for this installation were originally designed to operate as three-part pole machines, each pole being divided into three sections, each section being provided with separate shunt windings. In this type of machine in order

to reduce the direct voltage without changing the alternating voltage the field-strength of the outer sections of each pole is reduced, while the field-strength of the middle section is increased. This change in the distribution of the field flux producing a variation in the voltage ratio of conversion. The excitation for the main-pole sections is obtained from a 230-volt exciter bus and the windings on the auxiliary-pole sections are excited from a specially designed synchronous exciter.

The exciter in this installation is an eight-pole machine. The armature being provided with a four-pole winding and driven by a four-pole synchronous motor. There are eight brushes bearing on the commutator, four of these being the auxiliary brushes, which are short-circuited, while the other four are connected in pairs and constitute the main terminals of the machine.

For supplying alternating current to this exciter, a current transformer is connected in each phase of each of the main generators. These current transformers are connected to a set of common totalizing bus bars, which in turn are connected to the primaries of three totalizing current transformers. The secondary windings of the latter are connected to the collector rings of the exciter. This arrangement was made necessary owing to the fact that there is no point in the main *A C* bus bars of the station through which the entire output of the plant passes—the outgoing *A C* feeders being connected at various intermediate points between the points of connection of the main generators, so that there is no point in the bus bars where a single set of current transformers could be connected for regulating the total load.

Inasmuch as the main bus bars of the station are installed in duplicate, it was found necessary to duplicate the totalizing bus bars for the current transformers. The switching arrangements are such that any number of the main generators may be connected to one set of bus bars while others may be connected to the other set. The feeders may also be divided between the two sets. The split-pole convertors may be connected to either set of bus bars for regulating. The oil switches which connect the generators and the convertors to the bus bars are installed in duplicate, one set for each set of bus bars. The oil switches are provided with pallet switches, interlocked in such a way that when the convertor is connected to one set of main bus bars the totalizing current transformers are connected to the corresponding

totalizing current transformer bus bars. When any generator is connected to either set of bus bars, its current transformers are connected to the corresponding totalizing current transformer bus bars. The exciter therefore responds to the fluctuations of load on only those generators which are connected to the bus bars to which the split-pole converter is connected. The totalizing-current-transformer bus bars, which are not in use for regulating at any time, are automatically short-circuited.

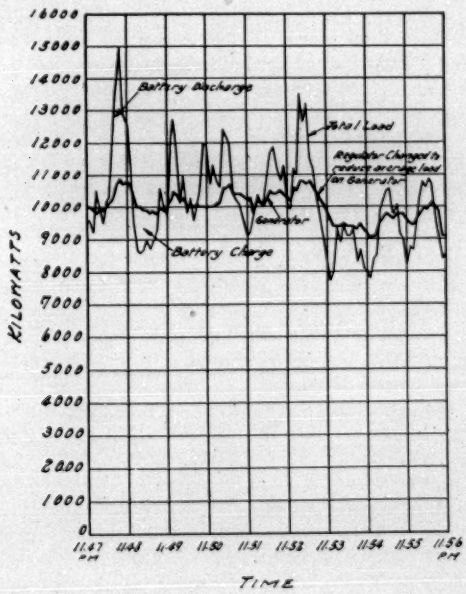
The battery is also arranged to regulate the fluctuations of load on the direct-current bus bars, but, as previously shown, the direct-current load is only a small portion of the total, is not extremely fluctuating and contains no features of special interest. This regulation is obtained by means of two direct-current boosters connected between the battery and direct-current bus; these can be operated singly or in parallel. The boosters are provided with carbon-regulator control in the usual manner, the carbon regulator being actuated by a soft-iron horseshoe magnet suspended over a section of the direct-current bus bar. The operation of these boosters in conjunction with the battery is like any other direct-current regulating plant, and is well known.

Fig. 6 shows the regulation obtained by the battery on the *A C* bus bars. In this diagram the heavy line represents the total load on the alternators, whose load is being regulated, while the light line is the total load on the station, the difference between the two lines showing the discharge or charge of the battery. The curves are plotted in kilowatts, the alternator load being taken by a recording wattmeter connected in the circuit of the totalizing-current transformers and calibrated to suit the ratio of same, while the battery output was calculated from readings of the current and voltage taken every five seconds from the ammeter and voltmeter. It will be noted that during the first six minutes shown on the curve the load on the alternator is held between 9800 and 10,900 k.w., and during the latter portion of the curve the average load was changed and was held between 9000 and 10,020 k.w. During the entire period of the curve the maximum variation of the load on the station was from 7700 to 15,000 k.w., a change of 7300 k.w. During the period of this curve the battery output varied from 4100 k.w. discharge to 1800 k.w. charge.

The practical commercial results obtained from the storage battery in actual operation have been extremely satisfactory and

gratifying to all concerned, and the following features have been most clearly demonstrated: Regulation of both *A C* and *D C* loads making the parallel operation of large gas engine driven alternators under fluctuating load conditions entirely practicable. An interesting point in connection with this feature is the marked effect of the battery regulation on the gas-engine driven alter-

FIG. 6.




nators located in the South Chicago plant of the Illinois Steel Co., some 11 miles away from Gary, but which is connected to it in parallel by a three-phase tie line. When for any reason the battery at Gary is disconnected or the tie line between the power stations is opened, a most decided difference is noticed in the operation of the South Chicago engines. One of the most

obvious practical commercial results of the battery regulations is the increased speed at which the large rail mill is operated. If for any reason the battery is disconnected, the output of the rail mill is materially reduced. The emergency feature is very valuable and enables the most important portion of the load to be carried uninterruptedly through times of interruption of service, due to line or other troubles which of necessity will occur in plants of such magnitude and covering such a wide area of distribution. The vital necessity for continuity of service in steel mills is well understood, and the effect of the battery in preventing costly delays and adding the safety feature, which cannot be estimated in dollars, undoubtedly warrants the investment for the battery, even if this were not largely offset by the saving in investment for additional generator capacity which the battery replaces. The results obtained at this plant indicate that the storage battery is an indispensable part of such an equipment.

This plant has been in operation about two years and plans are now under way for doubling the size of the power house and storage battery equipment.

In connection with the regulation of fluctuating loads by means of storage batteries there is one development I wish to mention to-night, as it shows the high state of perfection to which this class of work has been brought. It is a device to enable the storage battery equipment to take the quick fluctuations, relieving the generating machinery of them entirely but throwing slowly onto the generators fluctuations which are sustained for any length of time.

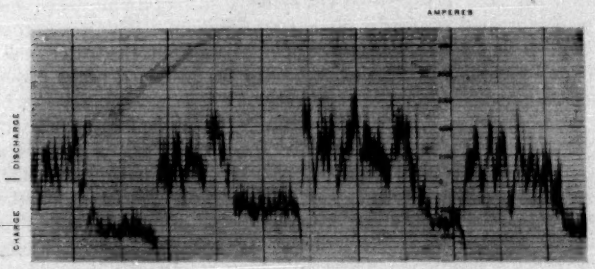
Heretofore the booster regulating systems have not been designed to differentiate between a rapid fluctuation and a slowing changing load; that is to say, if the regulator were set for a certain average load it would tend to hold the generators at that load regardless of the duration of the change in the outside demand; and the only method of altering the output of the generators was hand manipulation of the regulator. It has been found in a number of cases that the battery has not only had to take the fluctuations for which it was designed, but has also had to handle peaks of long duration on account of changes in load conditions which were not noted by the station operators.

The objections to this are twofold: First the station is not

running at its highest economy, and second, useless work is put upon the battery.

For these reasons there was developed an automatic device for changing the average load on the generators with sustained

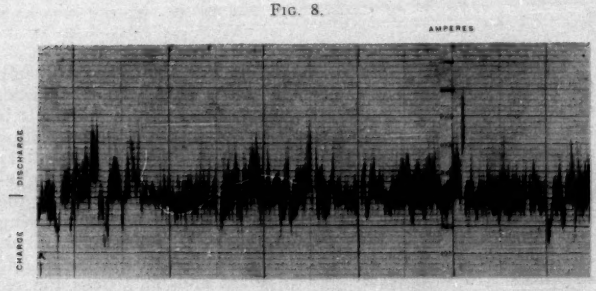
FIG. 7.




WITHOUT AVERAGE ADJUSTER

changes in the demand. This device consists of a small motor actuating the booster regulator through reducing gear. The principle of its action is that on a discharge of the battery the

FIG. 8.




WITH AVERAGE ADJUSTER

motor is operated so that it revolves in a direction slowly to raise the load on the generators. On a charge of the battery the motor runs in the opposite direction, thus slowly relieving the generators of load.

It is evident that a battery equipped with the average adjuster will still take the rapid fluctuations, but will not hold the generators to a fixed average, the sustained changes being gradually transferred from the battery to the machines.

To hold the generator load line below a fixed limit, a simple stop has been designed to open the adjuster circuit when the generator load reaches a predetermined point. The generators can thus be made to work up to any desired limit, the battery taking all the quick fluctuations and also the sustained peaks above that limit.

The accompanying diagrams, taken on a plant in actual service, illustrate clearly the action of the adjuster. Fig. 7 is a chart showing battery charge and discharge without the adjuster. Fig. 8 is a chart showing battery charge and discharge on the same system with the adjuster in operation. It will be noted that in Fig. 7, in addition to fluctuations, the peaks taken by the battery are considerable; while in Fig. 8 the battery takes the fluctuations, but does very little peak work.

The adjuster is of simple design, and it is believed that the improved economy of operation effected by it will make it an extremely valuable adjunct to battery installations operated in regulating service.

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**Control of Air in Buildings.** (*Eng. Rec.*, lxii, 7.)—Although the necessity for pure air in buildings has long been recognized, outside air was supplied without any attempt at purification. It is now recognized that an efficient air supply involves the regulation of temperature, humidity and purity. In foundries, storage-battery plants, potteries and many other industries it is necessary to remove fumes or dust to protect the workmen. Aside from the hygienic aspect, the successful operation of certain manufacturing operations, such as textiles, gelatin products, photographic films, and confections is to a large extent dependent upon atmospheric conditions. In such places as coal-mines and flour mills the removal of dust is necessary to prevent explosions. In cities where the air is contaminated by dust and smoke, the air should be purified either by cloth filters or washers; the latter removing dust and floating matter and to a certain extent the soluble gases. In many cases the increased efficiency of employees more than offsets the cost of the ventilating plant.

# THE PERMEABILITY OF PAINT FILMS.

BY

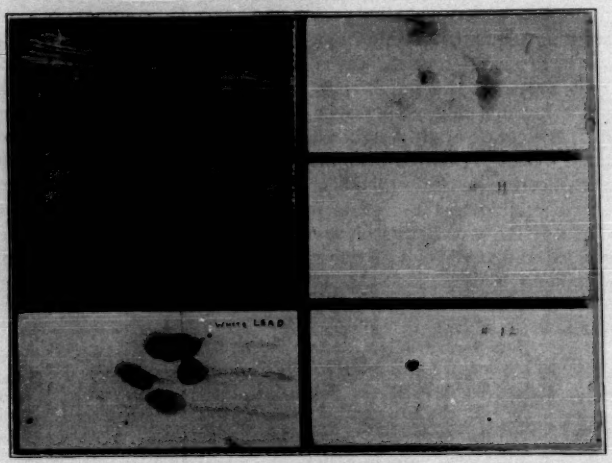
HENRY A. GARDNER.

THE writer some time ago made a series of tests to determine the water-excluding values of various combinations of painting pigments ground in pure linseed oil. White pine boards six inches long, four inches wide, and one inch thick were carefully prepared and numbered and given three coats of a white paint formula of the corresponding number. After drying, the boards were carefully weighed and immersed in a tub of water for three weeks. After removal, the surfaces of the boards were dried with blotting paper and the boards weighed. The gain in weight, corresponding to the amount of water penetrating through the pores of the wood, was observed. The boards were again immersed and at the end of two months the following results were obtained:

| Formula No. | | Grammes of water absorbed through peint |
|---|---|---|
| 1 | Soya Bean Oil | 120 |
| 2 | Linseed Oil | 102 |
| 3 | Calcium Sulphate | 93 |
| 4 | Barytes | 88 |
| 5 | Asbestine | 74 |
| 6 | Corroded White Lead | 59 |
| 7 | Basic Carb.—White Lead 25 per cent.<br>Basic Sulph.—White Lead 20 per cent.<br>Zinc Oxide 25 per cent.<br>Calcium Sulphate 25 per cent.<br>Calcium Carbonate 5 per cent. | 58 |
| 8 | Sublimed White Lead | 56 |
| 9 | Zinc Oxide | 56 |
| 10 | Zinc Lead White 30 per cent.<br>Zinc Oxide 40 per cent.<br>Basic Carb.—White Lead 20 per cent.<br>Calcium Carbonate 10 per cent. | 42 |
| 11 | Basic Carb.—White Lead 50 per cent.<br>Zinc Oxide 50 per cent. | 42 |
| 12 | Basic Carb.—White Lead 38 per cent.<br>Zinc Oxide 48 per cent.<br>Silica 14 per cent. | 38 |

The test boards were then exposed, with their content of water, to the action of the sun's rays. Blistering of the painted surfaces took place in many cases, caused by the rapid withdrawal of the water and its consequent action on the paint film. The tests seem to indicate that a mixture of white lead and zinc oxide, with or without a small percentage of the inert pigments,

FIG. 1.




Photograph of painted boards treated with indicators showing the relative permeability of the different paints applied.

Top panel painted with Soya bean oil. Middle panel painted with linseed oil. Bottom panel painted with white lead in oil.

Top panel painted with No. 7 formula. Middle panel painted with lead and zinc, No. 11 formula. Bottom panel painted with lead, zinc and silica, No. 12 formula.

is not as subject to the action of the water as the single pigment paints. In order, however, to corroborate these tests, it occurred to the writer to develop a more visible means of demonstrating the passage of moisture through paint films.

Another series of white pine boards were therefore soaked in a solution of iron sulphate for several hours. After removal, the surface of each board was dried and coated with one coat of the paints previously tested. After thorough drying for forty-eight

hours, there was placed on the surface of each board a few drops of a solution of potassium ferrocyanide. This solution has the effect of producing a blue coloration with iron sulphate, and in every case when it was placed on a paint of considerable porosity the solution penetrated through and formed a blue coloration beneath the paint. The results obtained on a few of the tests are shown herewith, and these results seem to corroborate the original tests referred to above (Fig. 1).

A series of sheets or films of paints were prepared by painting on glue-sized paper. Immersion of the painted paper in warm water allowed the removal of the paint films intact. These films were placed over a glass dialyzing cup, allowing the inner surface to sag so as to hold a small amount of dilute ammonium chloride solution. Distilled water was placed on the reverse side of the dialyzing apparatus and the test started. At the end of six days the distilled water in each test was examined and the following results obtained:

Test No. 1 (Corroded White Lead) allowed the passage of 0.003 Gm. ammonium chloride.
Test No. 2 (Corroded White Lead and Asbestine) allowed the passage of 0.002 Gm. ammonium chloride.
Test No. 3 (Corroded White Lead and Zinc Oxide) allowed the passage of 0.0003 Gm. ammonium chloride.

Tests were also made with dilute solutions of other salts such as ferric chloride, having a dilute solution of potassium sulphocyanide on the reverse side of the apparatus. In the latter case the formation of a pink color, characteristic upon the mingling of these solutions, was obtained in a few hours.

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**Earth Currents in Stockholm During the Transit of Halley's Comet.** D. STENQUIST AND E. PETRI. (*Nature*, lxxxiv, 9.)—Observations were made at the Central Telegraph Station at Stockholm, of earth currents on two lines: Stockholm Göletorg (resistance 2940 ohms) and Sundsvall-Stockholm (resistance 2336 ohms). Measurements made from minute to minute from 0 hrs. 40 min. to 3h. 45 min. The measured currents were considerably above the normal for the time of day, but not so large as during a magnetic storm. The greatest disturbances occurred shortly before and after 2 A.M. when the p.d. east to west was +68.1 and that north to south was +56.6 millivolts per k.m.

**Turbo-Electric Propulsion of Ships.** H. C. LEAKE. (*Electrician*, lxv, 19.)—The British Westinghouse Electric Co.'s system, invented by J. N. Bailey, comprises alternating-current, 3-phase, squirrel-cage motors, usually four in number, coupled direct to the propellers; each pair of motors is electrically connected, through reversing and isolating switches only, to a separately excited turbo-generator. Starting and speed regulation of the propellers is effected by starting, and by varying the revolutions, of the main turbines. For reversing at full speed these turbines are fitted with special steam brakes, which are applied until the frequency is sufficiently low to allow the reversing switches to be thrown over. The various operations are electrically controlled with alternative hand mechanism. Stress is laid on the great simplicity of the system.

**Change of Resistance of Metals at Different Temperatures in a Magnetic Field.** S. C. LAWS. (*Phil. Mag.*, xix, 685.)—Zinc, cadmium in the form of wire, and graphite were tested. Using the Wheatstone-bridge method, the resistance of the specimens was measured with the magnetic field off and on, the wires being wound on mica frames which could be immersed in an oil bath or in a vacuum vessel for holding liquid air. Denoting the resistance of the specimen by $r$, and its change of resistance by $\delta r$ in a magnetic field $H$, the ratio $\delta r/r$ is found to be proportional to $H^2$. For all three substances $\delta r/r$ increases at lower temperatures; the increase from ordinary temperature to that of liquid air being 20 times in the case of cadmium and zinc, and 3 times for graphite. The change of resistance in graphite varies approximately inversely as the absolute temperature.

**Glass and Metallic Grating Replicas.** J. A. ANDERSON. (*Astro. Phys. Jour.*, xxxi, 171.—The replica gratings made by taking casts in celluloid are found to give definition comparable with the original only when of small dimensions, the shrinkage during drying producing distortion. By introducing certain gums into the celluloid solution and heating the replica it is possible to produce a positive replica of the original grating. This can be coated with platinum, nickel or gold by Kathode deposition, or etched with hydrofluoric acid when wanted on glass or quartz.

**Substitute for Bath-brick.** The Britannia Patent Fire-lighter Co., Ltd., have patented the following process of making a polishing material. Glass works refuse, consisting chiefly of sand, emery, pumice stone and glass particles is pulverized and then passed through a refining machine to eliminate coarse material. The fine powder as obtained, or formed into bricks, is used for cleaning metallic surfaces or the like.

# MECHANICAL ENGINEERING PROBLEMS IN ILLUMINATING GAS WORKS.

BY

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(*Presented at the meeting of the Mechanical and Engineering Section, held Thursday, October 13, 1910.*)

[The problems which confront the mechanical engineer, who is connected with a gas plant, are brought to the notice of the reader. How these various questions may be solved to the best interests of all concerned is pointed out.]

THE business of the manufacture and distribution of gas for lighting, heating and power purposes constitutes one of the most familiar and important examples of that phase of modern civilization in which private capital, enjoying public privilege, undertakes to supply one of the conveniences or necessaries of living. With the gradual recognition of the mutuality of the relations between the Gas Company and the community which it serves has come a clearer conception of the obligations of both parties to the unwritten but none the less binding contract between them, and to-day it would be difficult to find a Gas Company whose officers do not feel in duty bound to render its customers the best service in its power at the lowest rate consistent with a fair return upon the capital invested. To accomplish this result it is essential that the management of the Gas Company, in its various departments, be expert, each in its particular duty; that the work in hand shall be performed by specially educated and carefully trained men. In no department of the business is this more apparent than in the gas works itself, where technical problems of the most intricate character are continually offering themselves for solution. It is here that the young mechanical engineer begins to realize for what his course at school was intended to fit him, and gradually, as he learns to recognize the principles of efficiency, economy and the conservation of energy through their numerous and most cunning disguises he takes up his work of eliminating waste, extravagance and engineering fallacies.

The modern illuminating gas works is a highly specialized plant, designed for the duty of gasifying coal, either by distillation in an enclosed retort, or else, by making from it, hydrogen and carbonic oxide by the action of steam, and adding thereto the light-giving vapors of liquid hydrocarbons. The former method is known as the coal gas process; the latter as the water gas process.

Before discussing the mechanical engineering problems which

FIG. 1.

A pump room. The pumps shown in this illustration are for the purpose of handling hot and cold water, oil, tar, ammonia, etc. The services of a mechanical engineer are valuable in such work as this.

are met with in the design and operation of a gas works, it might be profitable to define that branch of engineering which is called mechanical. In the best known schools of mechanical engineering the course of instruction includes, among other things, the following subjects: Mathematics, to and including Thermodynamics; Modern Languages; Mechanical Drawing and Machine Design; Physics; General Chemistry, and Special Engineering Chemistry, including Combustion Engineering; Engineering Practice; Structural Engineering; Electrical Engineering. Hand in hand with

instruction in the theory of the foregoing subjects, the scholar is given practical work in physical, chemical and mechanical laboratories. It will be seen that this course of instruction prepares the mechanical engineer for all branches of industrial undertakings in which success depends upon the efficiency of the means and methods employed and upon other economies of operation. He is trained to save; to do work with the least expenditure of energy; to consider no economy too small to be worthy of attention,

FIG. 2.

Positive blowers compressing air from atmospheric pressure to one pound, for use in a large carburetted water-gas plant. In this case the amount of work to be done is comparatively great and the utmost economy of operation is sought by the use of Corliss engines and efficient blowers, regardless of first cost.

knowing that in the aggregate many small economies may determine the success or failure of the enterprise as a whole. The system of instruction which instils the theory of an operation and at the same time illustrates the theory in practice enables the mechanical engineer to foresee the direction in which success may be attained; and at the same time the practical instruction in the laboratories and shops saves him from the pitfalls in which the pure theorist is certain to flounder with fatal result.

In the treatment of the coal through the various stages of manufacture to the completed product, the gas manager is confronted with problems of efficiency and appropriate design; the phenomena of combustion; the handling of heavy and bulky materials; with chemical reactions of the most complicated nature. In order to insure good service, continuity of the supply of gas both as to quantity and quality, and a stable, profitable business, it is necessary so to design the plant that it possesses entire reliability, and so to operate it that the greatest net profit is obtained. With extravagance in first cost or wasteful operating methods, whether due to design or bad management, what might have been a highly attractive undertaking in which capital would readily seek investment, soon degenerates into an over-capitalized and unprofitable operation with a reduction, or entire loss, of credit, meeting finally the expensive process of a reorganization. It is therefore at the very outset that mechanical problems are met and must be correctly solved before we may intelligently determine how to build the plant so that the high efficiencies and rigid economies necessary to success may be obtained. It is not alone sufficient to know that a given piece of apparatus will perform its function with the highest efficiency; the questions must be asked: What does this efficiency cost? Will it pay to make the investment? Will it pay, for example, to purchase machinery to unload the coal, and if so, what kind of machinery? What is the cost of operating this machinery, for steam, repairs, deprecation and attendance? Would it not be wiser to avoid locking up so much money in coal-handling machinery, which may be obsolete in a few years, and rather rely upon common labor, which, though costing a little more perhaps, all things considered, does not rust, carries with it no interest charge, and is so flexible that it may be employed in numerous other operations besides the unloading of coal? All the above are mechanical engineering problems.

While the construction of the foundations of the buildings in a gas works and the strength and other characteristics of the materials employed may be properly the business of the civil engineer, and while the chemical reactions involved in the generation and purification of the gas may strictly fall within the province of the chemist, still it will not be denied that the appropriateness of the design of the structures, both as to first

cost and the facilities offered for economies in labor, the efficiency with which the chemical reactions are produced, and the thermal and mechanical efficiencies of the apparatus employed, are purely mechanical engineering problems.

One of the first problems of the mechanical engineer in the gas works is the receipt and storage of the coal for gas making and for boiler fuel. He must decide whether the amount of material to be handled will warrant the installation of mechanical unloading devices. Upon his knowledge of the cost of operating and the durability of this class of machinery depends the wisdom of the decision, and without special knowledge of this subject a mistake would probably be made which would materially affect the cost of a unit volume of the product. For example, it would not pay to invest $5000 in machinery to handle from the car to the bin the 1000 tons of anthracite coal that will be needed in a carburetted water gas plant supplying a city of 25,000 inhabitants. The steam and labor of attention necessary to operate the machinery will cost 5 cents a ton, and the interest (5 per cent.) and depreciation (10 per cent.) will add 75 cents more. Utilizing a simple hydraulic elevator costing $1000, a laborer, at 25 cents for his wages, will put up one ton per hour, and the interest and depreciation at 10 per cent. on $1000 will bring the cost up to 35 cents. If to this we add 5 cents a ton for operating the elevator pump, we find that by the adoption of the second method we have saved 40 cents a ton in handling the coal. But the $5000-elevator will handle 5000 tons at the same cost for interest and depreciation as it did the 1000 tons. Its installation, therefore, in a plant of five times the size of the one first assumed will be justified, for then the comparison would be:

For the $5000 elevator:

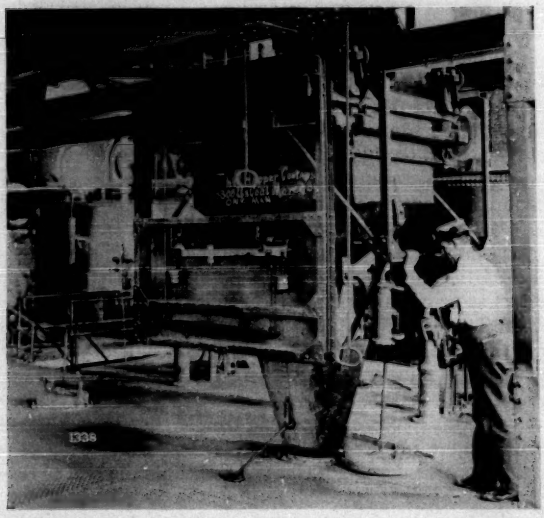
| | Cents. |
|---|---|
| Interest and depreciation | 15 |
| Operating expenses | 5 |
| Total cost of coal handling per ton | 20 |

For the $1000 elevator and common labor:

| | Cents. |
|---|---|
| Interest and depreciation | 2 |
| Labor of operating | 25 |
| Steam for elevator pump | 5 |
| Total cost of coal handling per ton | 32 |

The above example will serve to illustrate one phase of mechanical engineering in receiving and storing coal in a gas works yard. The manager will make mistakes unless he always asks himself the question: Will it pay? Does the proposed investment bring the greatest return upon each dollar of capital? Is there not some other way of accomplishing the purpose which,

FIG. 3.



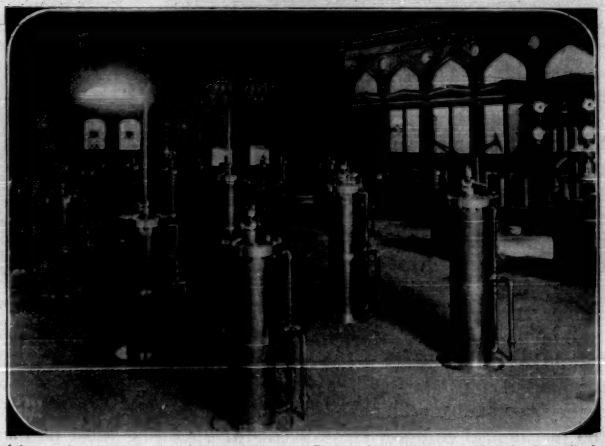
In addition to the fuel-weighing machine shown above, the mechanical engineer has applied methods of precision in the measurement of air required for blasting, the steam for producing water-gas and the oil for curburetting the water-gas. His effort has always been in the direction of replacing the old haphazard methods of gas-making with those of scientific accuracy.

during the assumed life of the apparatus employed, will show a greater net return?

Of less magnitude, but none the less necessary to the smooth running of the plant, are the mechanical engineering problems encountered in selecting the moving machinery required and in maintaining these machines in an efficient condition. For instance, the ratio of the water cylinders to the steam cylinders of

the elevator pump should be the inverse of that for the oil unloading pump, if the work in each case is to be done with good efficiency. The engines which drive the blowers for furnishing blast to the generators should be chosen only after giving due consideration to reliability, thermal efficiency, first cost and durability. The volume of business done by some particular gas company may be so small that it cannot afford the best apparatus in the market; the interest item outweighs all others combined, and the mechanical engineer recognizes this and buys a cheap

FIG. 4.



A labor-saving device—the hydraulic cylinder. By simply turning a small cock, the cylinder shown above will open and close valve gates weighing many hundred pounds.

10-horse power blowing outfit that will last long enough, or until the business has grown large enough to afford something better; but in large stations when the horsepower involved may and often does reach several hundred, the cost for interest and depreciation, even for the best that money can buy, is of less importance, compared with the cost of steam for operation; and the most efficient blowing unit obtainable should be installed, due consideration being given to the questions of durability, possible obsolescence or inadequacy in the near future. This suggests one of the most

puzzling problems of the mechanical engineer in the gas works: namely, that of selecting the right sized unit, whether it be an installation of coal gas benches, a water gas set, or a combination of both; whether he should recommend an increase of storage holder capacity or install greater generating capacity, and whether, in case greater holder capacity is decided upon, it should be located near the generating plant or at a distance; in the latter case supplemented with a pumping plant and high pressure mains. It is true that the solution of these questions involves also business judgment, for instance, in making extensions of plant. This can be done in small successive instalments, each sufficing for a short time in the future, as growth of business shall demand; this while conservative and safe, may result in ultimate high total capitalization, due to greater cost of successive small extensions and changes. On the other hand, extensions may be made on a large scale sufficing for a long time at a much lower cost for a given capacity, but this subjects the business to the risk of heavy interest charges if its growth is not rapid, or to heavy replacement costs if improved apparatus be substituted for old. Sound judgment as to business prospects is here required, but after its exercise there is equally important use for the knowledge and judgment of the engineer, even if much that is ordinarily called business judgment is not itself the application of mathematical or of engineering principles.

Having designed and built a gas plant, with constant consideration of the result to be obtained, with an eye to thermal, mechanical and labor efficiencies, with the least expenditure of money compatible with the utmost reliability and fair durability, the mechanical engineering problems of operating must be met. One of the most important of these is the quality of the raw materials. Since it is the business of the mechanical engineer to secure the greatest possible quantity of heat units and light units in the finished product for each dollar expended for raw material, it is important that he does not handicap himself at the start by purchasing inferior raw materials. Although there is a growing tendency towards the purchase of coal on the basis of its heat value, still this practice is not by any means general, and it is customary for the engineer to purchase coal regardless of the percentage of fixed carbon, volatile combustible, ash, sulphur and water. How important a matter this is may be seen

by reference to two analyses given below of samples of coke which, when good, is a most excellent gas-making fuel. Two analyses of bituminous steam coal are also given.

| | COKE. | | STEAM COAL. | |
|---|---|---|---|---|
| | No. 1. | No. 2. | No. 3. | No. 4. |
| | Per cent. | Per cent. | Per cent. | Per cent. |
| Moisture | 15.0 | 1.5 | 0.73 | 12.71 |
| Volatile combustible | 5.0 | 3.0 | 17.43 | 28.62 |
| Ash | 15.0 | 5.0 | 4.63 | 20.78 |
| Sulphur | 1.0 | 0.5 | 0.62 | 3.69 |
| Fixed carbon | 64.0 | 90.0 | 77.71 | 34.87 |
| | 100.0 | 100.0 | 101.12 | 100.67 |
| B.T.U | | | 15,178 | 8,840 |

The sample No. 1 had been exposed to heavy rains, or it had been flooded when quenched, was badly burnt off in the first place and was the product from a seam of coal containing much ash and sulphur. From a mechanical engineering stand-point only the fixed carbon is of certain value for making carburetted water gas. Consequently the gas manager has actually paid 40 per cent. ($0.9 \div 0.64 = 1.4$) more for his fuel in purchasing sample No. 1 than in purchasing sample No. 2. Although he may not be able to control the dealers in the matter of the analysis of their coal, he is, to some extent, in command of the situation, owing to the fact that he may restrict his purchases to certain coal fields where the quality is good and uniform. He may also insist upon proper methods of quenching, and upon the shipment of the coke in covered cars or failing to be able to keep the coke dry en route, he may find that it will pay to build sufficient storage at the works to permit a partial drying out under cover.

One of the most troublesome problems to be met with in a gas works is that of labor. It might be said that this is not particularly a mechanical engineering problem, since all employers of labor must encounter it. Still, it is more the problem of the mechanical engineer than of any other, because he is, by education and experience, best fitted to reduce the amount of human labor required, and this is what he is continually attempting to do by the adoption of labor saving appliances, such as bucket elevators,

belt conveyors, hydraulically operated valves and lifts, compressed-air drip pumps, mechanical stokers for coal gas retorts and for the boilers. In this field of endeavor he has no competitor. In common with many of his mates in other industrial enterprises, the mechanical engineer in the gas works has the problem of boiling water for making steam. No one will admit that this is, as a rule, intelligently and efficiently done to-day. And yet, knowing this, our practice and methods are not greatly different from what they were two thousand years ago. It

FIG. 5.

A Diesel engine power plant in which water-gas tar is the fuel, and where 25-cycle A. C current is produced for power purposes, with a consumption of one-tenth of a gallon of tar per horsepower hour

is still believed that in boiler practice 50 per cent. excess air of combustion is necessary for best results, whereas, in almost every other form of combustion with which we are familiar, science has reduced the necessary quantity of air to the theoretical amount. As illustrating the waste due to 50 per cent. excess air in the ordinary boiler efficiencies, it may be calculated that such a percentage of excess means an increase of 10 per cent. in the total fuel consumed. In the year 1909 there were used in the

United States under boiler furnaces for producing steam, approximately 340 million tons of coal. If this steam could have been produced by the combustion of coal with the *theoretical* amount of air, the saving would have been 34 million tons which, at an average price of $3.00 per ton, would amount to one hundred million dollars. Which of our young mechanical engineers, who are now earning their spurs at their chosen profession, will undertake to stop this waste and show us how to advance in the art of producing steam?

In a gas works a large percentage of the cost of the finished product is incurred in the generator of the water gas plant, or in the furnace of the coal gas bench. Here the problem is the apparently simple one of the combustion of carbon at temperatures above 2000° F. However, owing to impurities in the fuel, such as ash of variable fusion temperatures, extra complications are introduced which make the operation extremely difficult. Clinkers—the bugbear of everyone who burns coal, sooner or later, as the operation continues—upset all nicely calculated adjustments, and, unless means and methods are adopted to vary the air and steam of combustion so as to bring about a readjustment, serious losses will result, both in efficiency of production and in the quality of the finished product. It is now that we find the mechanical engineer hard put to it, and it is only by combining his knowledge of the theory of combustion with his practical experience in doing things that he is able to supply the demand for gas and render the good service which the community expects of him. Lack of such knowledge and practical resourcefulness must be compensated for by increased investment for spare machinery, making it still more difficult to obtain the desired profit.

Many other interesting and important mechanical engineering problems might be mentioned, but enough has been said to indicate that the business of gas making is largely the work of the mechanical engineer. Even the abstruse reactions within the coal gas retort and the water gas carburetter are not entirely outside his field. Though they properly belong to the chemical engineer, still, the education of the mechanical engineer of to-day fits him for such work, should he care to specialize in it. Indeed, so satisfactorily does the young mechanical engineer attack and

master the work in a gas plant, that some gas companies have entirely restricted additions to their engineering forces to this class.

When we consider the immense amount of intelligent work which has been expended upon the engineering problems in a gas works, it is not to be expected that any very great economies in manufacture will be made. What reductions in the cost of the finished product will be made will be accomplished by close attention to the small savings possible in increasing thermal and mechanical efficiencies and in the substitution of mechanical appliances for human labor. These are problems which will be solved only by the trained mechanical engineer.

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**Heat Capacity of Metals and Metallic Compounds.** H. SCHIMPFF. (*Zeit. Phys. Chem.*, lxxi, 257.)—The heat capacities of 15 pure metals and 29 metal compounds have been determined by the method of mixtures in the three temperature intervals 17°C. to 100°C., 17°C. to —79°C. and 17°C. to —190°C., and the results agree very closely with the calculated values of the specific heats. Between +50°C. and —150°C. the temperature coefficient of specific heat decreases with rising temperature for both metals and the inter-metallic compounds, except in the cases of lead and bismuth. In general the difference between the observed and calculated values of the specific heats of the inter-metallic compounds lies within 4 per cent. The observed specific heats of magnesium alloys are lower, and those of antimony alloys are higher than the calculated values. The atomic heats of metals and metallic compounds increase with increasing temperature.

**Tar Roads.** (*Eng. Rec.*, lxii, 7.)—In 1909 the Massachusetts State Highway Commission used English spraying machines to apply tar coatings to road surfaces. The tar is heated by a coil supplied with steam from a traction engine. The tar is kept under pressure by pumps geared to the wheels of the truck so that the motion of the tar spraying machine develops the necessary pressure. The hot tar is spread through a number of small nipples which throw a fine spray, and spread it upon the road in a thin and even coat. A hood over the nipples prevents the tar from being blown to one side by the wind. When a heavy grade of oil is used and applied hot at the rate of half a gallon per square yard the cost is said to vary beteen 6 and 11 cents per square yard, including material, labor, and the surface covering of sand, gravel, or stone-screenings.

# VACUUM-TUBE LIGHTING.

BY

D. McFARLAN MOORE.

(*Presented at the Stated Meeting of the Institute held Wednesday, September 21, 1910.*)

[The paper refers to the investigations in connection with vacuum-tube lighting and the results obtained by the author during the course of his experiments which have covered a period of sixteen years.]

VACUUM-TUBE lighting is the term that is usually applied to that form of light produced by the flow of a current of electricity through various kinds of rarefied gases confined within clear glass tubes. Such tubes under the name of the Moore Light to-day occupy a position in the great field of illumination, that is most important. Their light is produced in a way that is radically different from all of the ordinary methods long in use. The resultant illumination possesses distinctive attributes that command the earnest attention of all scientific men now, and is the harbinger of still greater scientific triumphs of the immediate future.

It is very interesting to note that although vacuum-tube lighting is a comparatively new commercial industry, nevertheless its underlying principle was noted at the very beginning of electrical science. In fact the very first electrical machine ever invented and constructed produced a small glow of vacuum-tube light as a by-product. I refer to the glass sphere of Hawksbee, who generated static electricity from it in 1750 by the friction of his hands as it revolved in trunnions. The air had been exhausted from its interior to such an extent that the static electricity caused the residue to appear as a suffused glow. But it was not until about a hundred years later that any real progress was made in this direction. It was then that Geissler in Germany attached the two high-potential terminal wires from an induction coil to the two ends of a small glass tube into which he had sealed short pieces of platinum wire and then exhausted the air from the tube. The high potential current caused these little tubes

to apparently glow quite brightly for a few moments before the vacuum deteriorated to such an extent that the light became extinguished. Crookes in 1879 made his famous investigations with similar tubes, but due to the extremely light degree of vacuum he employed the quantity of light produced was less rather than greater so that when your lecturer commenced his investigations sixteen years ago, the only foundation upon which to rest any hope for a new and improved method of producing commercial electric light was the extremely meagre Geissler

TABLE I.

CHRONOLOGICAL DEVELOPMENT OF SALIENT FACTORS OF THE MOORE LIGHT.

| Time | Source | Break | Coil | Lamp | Gas or Chemical |
|---|---|---|---|---|---|
| 1894 | Battery..... | Air vibrator | Primary and secondary | Geissler tube..... | ——— |
| 1894 | Street circuit | Vacuum vibrator | Primary only... | Bulb lamps..... | ——— |
| 1896 | Street circuit | Vacuum vibrator | Primary only... | Tubes, external caps | Wood alcohol |
| 1898 | Street circuit | Vacuum vibrator | Vacuum rotator | Tubes, external caps | Wood alcohol |
| 1899 | Low fre. generator | None..... | Resonance coils | Tubes, external caps | Wood alcohol |
| 1901 | High fre. generator | None..... | None..... | Tubes, external caps | Aubepine |
| 1902 | High fre. generator | None..... | High fre. transformer | Tube 100 ft., terminals in box | Graphitic acid |
| 1903 | High fre. generator | None..... | High fre. transformer | Internal electrodes | Rosalic acid |
| 1904 | 60 ~ Street | None..... | Standard transformer | Internal electrodes | Rosalic acid |
| 1905 | 60 ~ Street... | None..... | Standard transformer | Internal electrodes | Air through-feed valve |
| 1906 | 60 ~ Street... | None..... | Standard transformer | Internal electrodes | Nitrogen through-feed valve |
| 1906 | 60 ~ Street... | None..... | Standard transformer | Internal electrodes | $CO_2$ through-feed valve |
| 1909 | 60 ~ Street... | None..... | Standard transformer | Internal electrodes, semi-portable window | $CO_2$ through-feed valve |
| 1910 | 60 ~ Street... | None..... | Standard transformer | Portable window, invertable valve | $CO_2$ through-feed valve |

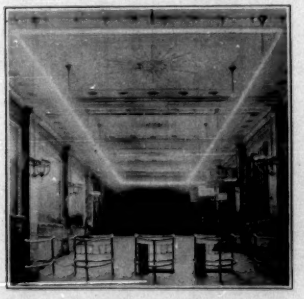
tube. The outlook was dubious, nevertheless theory pointed that way, and once more important scientific advance becomes debtor to "blind faith" that struggles dauntlessly forward no matter how dark and foreboding the prospects. The watchwords have ever been "try once more for the last time" and "there must be some way out." Due to unrelenting toil and many thousands of disheartening experiments it can now be said, "something useful is attained."

It will be noticed by referring to Table I that the five most

salient factors of this system of illumination can be helpfully considered as the links of a chain and that the development of the system consisted essentially in the continual necessity of strengthening first one link and then another.

One extremely important advance will be noted in 1899 when all "make-and-break" systems were finally superseded by static transformers receiving their energy from alternating dynamos, and again in 1905 when the automagnetic gas-feed valve made its appearance and began to occupy a place of great importance which it still holds. One of the first tubes installed equipped with such a feed valve is shown in Fig. 1 (Madison Square Garden). This tube is still in nightly operation and produces five times

FIG. 1.



Madison Square Garden, N. Y. Lighted with Moore tube.

as efficient an illumination as that of the incandescent lamps previously used to illuminate the same area.

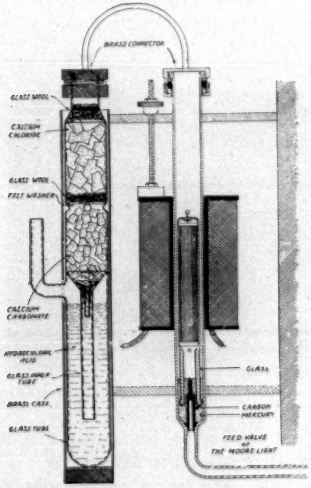
The heart, or rather the lungs, of the whole system, since it breathes, is the feed valve, which is shown in detail by Fig. 2. The small carbon plug when not completely covered by the mercury permits air or any gas to filter through it and then to pass into the large light-giving tube. The mercury of course cannot pass through the pores of the carbon and when it covers the carbon entirely, absolutely shuts off the passage of any gas through the carbon plug. The tip of this carbon plug is only exposed when the glass tube surrounding it is raised which thereby causes the surface of the mercury to lower.

The automatic manner of lowering and raising the surface of the miniature pool of mercury, that is, opening and closing this gas tube, is best shown diagrammatically in Fig. 3.

The glass tube, the lower end of which rests in the mercury, has its upper end filled with iron wire which acts as the core of a solenoid, that is, connected in series with the low tension side of a transformer, fed from the street alternating current mains.

Therefore, this gas-feed valve opens and closes as the cur-

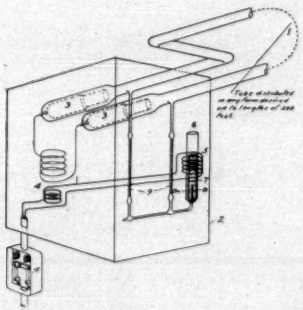
FIG. 2.




rent flowing through the solenoid becomes greater or less in direct proportion as the potential flowing through the gaseous conductor of the long light-giving tube changes. This current gradually becomes slightly greater as the conductivity of the gaseous-conductor increases, due to the degree of vacuum in the tube becoming higher, as the quantity of the gas in the tube is used up by the passage of the electric current. The momentary influx of a fresh supply of gas therefore automatically

shuts itself off by the weakening of the solenoid. A careful study of the current curve plotted in Fig. 4 makes the simple though effective action of the valve perfectly clear. It is so frictionless that it often acts with perfect reliability every minute for 10,000 hours. Any desired kind of gas can be fed to it, but it has been found that carbon dioxide yields a spectrum that is the equivalent of daylight. When this gas is desired it is generated automatically as shown by a portion of the apparatus in Fig. 2. That is, the lighting tubes' automatic demand for gas creates a slight vacuum that raises the hydrochloric acid into contact with the calcium carbonate, but only for a few moments at a time,

FIG. 3.



1, The Moore tube; 2, terminal box; 3, terminal electrodes; 4, transformer; 5, feed-valve coil; 6, glass tube of feed valve; 7, glass and iron wire displacer; 8, porous plug; 8a, mercury; 9, sand resistance tubes; 10, 220-volt, 60-cycle a. c. supply.

or until the very small amount of gas needed is generated.

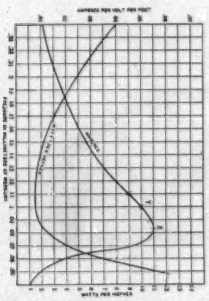
The automagnetic feed-valve solved a problem that seemed impossible because the factors involved were of such a delicate order. Primarily the problem was to maintain within 1/100,000 of an atmosphere a tube volume of about 5000 cubic inches at a degree of vacuum corresponding with 1/10,000 of an atmosphere. This extremely small permissible variation in gaseous pressure is not discernible on a barometric column, therefore the solution of the problem could hardly be approached by purely pneumatic or mechanical means but the electrical solution is due to the fact that minute changes in gaseous pressure correspond

to comparatively great changes in the conductivity of the gaseous-conductor. That is, a change of 1/100,000 of 1 per cent. of an atmosphere corresponds to a change of about 4 per cent. in the amperes flowing through the light-giving tube.

If the valve on such a tube is intentionally made inoperative, the light of the tube almost immediately begins to flicker and in a few minutes the light literally dies out for want of breath.

Many uses have been made of the light; it has been installed for banquets (as will be seen in Fig. 5), for use in hardware stores, machine shops, shoe stores, offices and art stores, baths, florists' shops, show windows, at ribbon counters, in silk mills, in photo-

FIG. 4.



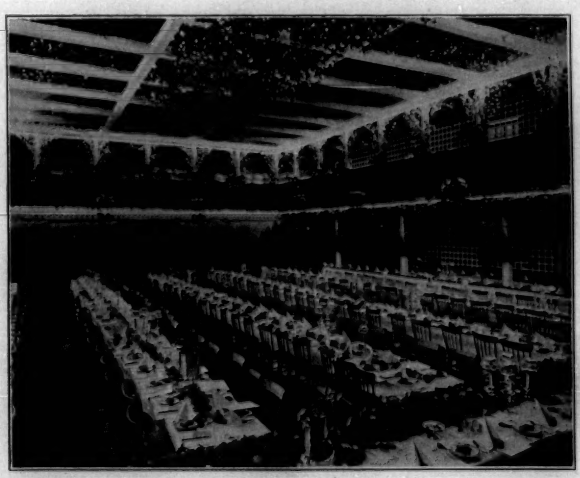
graphic studios, and a mile of yellow Moore light is in operation at the New York Post-Office (Fig. 6). The latter is produced by feeding it with automatically prepared nitrogen gas, resulting in a most efficient form of illumination.

The long tubes are constructed in innumerable shapes, but there is a small and compact or portable form of tube, which is designated "artificial window." When these "windows" are supplied with $CO_2$, the spectrum of average daylight is produced which has proven itself most valuable to many classes of business in which color values are of prime importance. For example, 10,000 operatives in dyeing establishments were able last winter to work on full time solely

because of the white Moore Light. No other form of artificial light has enabled the dyers to operate at night or on dark days. All of the primary colors as well as their shades are seriously distorted by all forms of light except that from the carbon dioxide vacuum-tube, a fact substantiated by all of the highest commercial and scientific authorities including the official report of the U. S. Bureau of Standards.

Commercializing the Moore Light has involved the design

FIG. 5.



Dinner in honor of President Taft, Passaic, N. J., May 9, 1910. Lighted with Moore tubes.

and invention of many auxiliary devices, such as the tools for cutting and joining the glass tubes, with suitable pumps for exhausting them.

Hundreds of experiments were necessary in determining the best kinds of gaseous conductors for various purposes. But this aspect alone of this new industry is so vast that it will probably be some time before it can be claimed to have been thoroughly explored. It would be difficult indeed to cite a field of scientific

research more full of promise. Very probably the gaseous-conductors now used correspond to the old carbon filament or a gas jet without a mantle. The latter forms one of the best illustrations of the enormous advantages accruing from selective luminescence. Gases will be found which when placed in the path of the vacuum-tube discharge or current flow will increase the efficiency of this light source, just as thorium and cerium did so wonderfully for the open gas flame. When this occurs

FIG. 6.

Installation at New York Post-Office, yellow light.

a very long step will have been taken towards the theoretical limit of efficiency for producing useful light for the human eye. Cheaper light is demanded by commerce as well as science, but the limit has evidently been reached so far as obtaining it by heating solids, while on the contrary we are just beginning the fight on the principle that is correct theoretically, viz., obtaining light by setting up the proper rates of vibration for the various colors, in gases, either by electrical or chemical means. There

is every reason for believing that a complete solution will be effected by adhering to the electrical means now employed but nature also stands ever ready with her fire-fly, like an open challenge to the scientific world to produce commercial light in the same manner, which is evidently chemical.

The necessary factors seem to be sodium or magnesium, formic acid and oxygen. But commercial electrical luminescence will doubtless be the next great and necessary stepping-stone, to hold for a time the attention on the grand march of light development, and to a future generation may be left the complete mastery, through commercial. chemical luminescence.

[NOTE.—Numerous lantern slides covering the historic as well as the technical side of the subject were shown during the reading of the paper and specimens of the white and yellow lights were in operation. Cloths of various colors were shown under the ordinary tungsten light and under Moore white light with a view to demonstrating the value of the latter as a medium for bringing out the natural colors.]

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**Temperatures of Electric Steel Furnace.** PROF. BERNHARD NEUMAN. (*Iron Age*, lxxxvi, 6.)—The Professor discusses the claims of high temperatures for steel refining in the electric furnace. He refers to some temperature measurements made by Prof. J. W. Richards at the Heroult furnace of the Illinois Steel Co., at South Chicago, which were so low as to indicate that the electric steel on the average was not hotter than that in a Bessemer converter. The reason is that Bessemer steel is refined for only one or two hours, so that the steel is of good average quality, C=0.4, Mn=0.4, S=0.03, and P=0.03. Prof. Neumann gives temperature measurements made in a Nathusius furnace at Friedenshütte, which were about the same range as those noted at South Chicago.

**Tayabas Petroleum.** G. F. RICHMOND. (*Philippine Jour. of Sci.*, v, 1.)—A sample of crude petroleum, typical of that found in the Tayabas province, P. I., resembled Pennsylvanian petroleum in containing a fairly high proportion of volatile hydrocarbons, in having a paraffin base and in being free from sulphur. The proportion of volatile constituents boiling below 150° C. was greater than in most petroleum oils: sp. gr. 0.831, initial boiling point 70° C.; first fraction (light oils) 70° to 150° C., 36.5 per cent.; second fraction (burning oils) 150° to 300° C., 48.75 per cent.; and residue, above 300° C. (by difference) 14.75 per cent. It contained 30 per cent. of unsaturated hydrocarbons which could be removed by acid. It might be described as essentially a paraffin petroleum.

**Ferrosilicon Manufactured in the Electric Furnace.** F. W. HINRISCHEN. (*Mitt. Kgl. Materialprüfungsamt*, xxviii,, 283.)—This paper relates to investigations as to the cause of, and means of prevention of, accidents arising from the poisonous and explosive gases evolved from this material. These gases are chiefly phosphoretted hydrogen derived from the calcium phosphide. Some samples also contain arseniuretted hydrogen. The most dangerous grades are those containing from 30 to 70 per cent. of silicon. This article is well worth careful consideration by manufacturers, carriers and users of electric ferrosilicon.

**Development of Papers Giving a Visible Image of Silver Chloride.** J. DESALME. (*Bull. Soc. Franc. Phot.*, i, 207.)—Developers containing an amino group are the most suitable for the physical development of printing-out and similar papers. Developers containing two or more hydroxyl groups are not nearly so active. *p*-Aminophenol is the most useful of all the developers tried, the diamino compounds being so energetic as to be beyond control. By neutralizing the amino group, *e.g.*, with an organic acid, the action is retarded and the tone modified. Dimethyl-*p*-phenelenediamine is less rapid than *p*-phenylenediamine, whilst monoacetyl-*p*-phenylenediamine has no developing power. Methyl-*p*-aminophenol (metol) acts less energetically than *p*-aminophenol, but both are valuable physical developers when used in conjunction with tartaric, citric, or acetic acid.

**Thermal Conductivity of Fire-Clay.** J. K. CLEMENT AND W. L. EGY. (*Met. and Chem. Eng.*, viii, 414.)—The test-pieces were made into cylinders about 40 cm. long and 12 cm. in diameter with a hole through the centre for the heating coil, and four longitudinal holes, about 3 mm. in diameter, for the reception of thermocouples for the measurement of the temperature. The temperature inside was raised to between 400° and 900°C. during a time of 3 to 5 hours, and then kept constant for 2 or 3 hours more. When the outer couple showed a temperature constant to 0.1°C., the readings were taken. The cylinder was then broken across and the distances of the holes from the centre measured. From these data, together with the voltage and current readings of the heating coil, the conductivity can be calculated. It was found that in the case of two coarse fire-clays the conductivity was constant at 0.00264 and 0.0036 Gm. calories per cm. per second per 1°C. respectively, while for two finer fire-clays there was an increase from 0.0021 at 350°C. to 0.0022 at 600°C., and from 0.00245 at 500°C. to 0.0026 at 800°C. respectively. Knowing the thermal conductivity of brick the dimensions of a furnace, and the outside temperatures of the walls, the quantity of heat transmitted through them may be calculated. In the case of a 210 h.p. Heine boiler this was found to be 43.400.000 calories per hour.

# CELLULOSE.

BY

MR. CARL G. SCHWALBE.

[Translated from the *Moniteur Scientifique*, 24, 825.
By W. J. Williams. F. I. C.]

THE first attempts to substitute other prime materials for rags, old linen, or cotton waste for the manufacture of paper date from the middle of the eighteenth century. Even at this time these prime materials were getting scarce. Christian Schaeffer of Ratisbon, attempted in 1765 to make paper from wasp-nests, turf, straw, hay, the twigs of hops, from brush broom, and even from wood, but his efforts brought no results except the contempt and jeers of his contemporaries; the time had not yet come to realize this idea, and moreover the scarcity of rags had not yet become pressing. But when the development of daily newspapers, and the necessity of satisfying the demands arising from the extension of popular instruction, had made these ideas acceptable, the search for substitutes for rags became permissible; thus it was that towards the middle of the nineteenth century, the attempts of the weaver Keller to de-fibre wood so as to obtain a pulp, to replace the pulp from rags, were favorably considered. There should be remembered, too, the attempts made by Melliers, among others, who frequently tried to treat straw so as to extract from it a pulp which could be used industrially. Cellulose treated with soda soon followed the mechanical wood-pulp and straw-pulp. In fact, the process of treating wood, as well as straw with caustic alkalies or alkaline earths became a success. Moreover, very soon after this alkali process had been brought from America to Europe by Houghton, it found a competitor in the chalk process, or in the sulphurous acid or bisulphite process. The names of Tilghman and of Ekman are connected with the first experiments made in Germany to use calcium sulphite or magnesium sulphite for this treatment. At this time, this process which had been kept secret fell into oblivion. The energy and determination of

Mitscherlich and his licensees developed a practical industrial process, which, concurrently with the analogous process of Rittner-Kellner, soon brought the new industry to an extraordinary stage of development in the short space of 25 to 30 years.

The production of cellulose amounted to 1,600,000 tons, of the value of $80,000,000; the production in Germany was estimated at 564,000 tons, worth $28,000,000; the proportion of cellulose treated with caustic soda was very small. This was due to the fact, that for various reasons, still disputed, the bisulphite process of treating wood seemed superior to the soda process. However, in spite of the considerable extension of this process, in spite of the great progress it has made as to the yield, both in quantity and quality of the product, hence the certainty of the methods of manufacture, still the cellulose industry depends almost entirely on empiricism. The chemical composition of the raw material, wood, and of its manufactured product, cellulose, is still almost completely unknown to us.

The cellulose industry and its allied industries of cotton, gun-cotton, and artificial silk are thus in an analogous condition to some other industries, for example, the leather industry; from this point of view they are in a totally different condition to the great industry of inorganic chemical products or of coloring matters. In the case of these latter industries, the exact chemical knowledge of their raw materials and of their intermediary products has allowed them to advance very methodically and in well-chosen paths; and this has made their recognized brilliant development possible.

May I be permitted here to make a rapid sketch of what the cellulose industry and its allied industries are; to point out what problems are not yet solved, the solution of which is demanded as much by the chemist as by the technical man; and to express how necessary it is to base these industries upon more solid chemical knowledge than they actually possess at present?

To begin with, let us consider the manufacture of mechanical wood-pulp: 500,000 tons worth $12,500,000, are produced annually in Germany. At first sight this manufacture does not seem chemical. In fact, the decorticated wood is crushed flat between millstones and under a stream of water, either per-

pendicularly to the course of the fibre or with the fibre; the fibrous pulp thus obtained is refined, freed from splinters of wood, and then worked in different ways so as to yield various products, such as straw-board, but chiefly the substance to which a small quantity of cellulose is added to make the paper for the daily journals.

If one of the stages which this process has lately reached is studied, that known as the method of defibring by the hot process, which came from America, we are plunged at once in a chemical problem. In this method, as a preliminary treatment, recourse is had simultaneously to boiling water and a very high pressure, working at as low a temperature as possible.

Boiling with water under these conditions, when it is for a short time only, appears to dissolve a certain part of the wood and to yield a very large quantity of very long fibres, with a small residue of broken fibres. The effect naturally goes much farther if the water is allowed to act for too long a time and under greater pressure. To obtain very resistant fibres, certain constituents of the wood are dissociated, and then the custom is to recover them by the production of the brown mechanical pulp. This pulp is specially used to make a very strong leather-board. Unfortunately, carbonization begins during this process. According as the temperature and the pressure (4 atmospheres on the average) are more or less high, a correspondingly more or less marked brown color is produced. Is this due to the formation of humus? As vanillin and acetic, formic, and oxalic acids are found in the residual lye, it is not improbable that oxidation is set up.

It has been attempted to remove this extremely troublesome brown color by bleaching, but in vain. However, there appears to be some hope of success of preventing the production of this brown color, that is of preventing the oxidizing agents from acting; to effect this, either the air in the autoclave (digester) and in the pores of the wood is removed by producing a vacuum in the autoclave, or, before boiling, the wood is impregnated with a solution of a reducing agent, such as sodium sulphide. Besides this question of discoloration, other technical problems present themselves; in any case there is the utilization of the residual lye, which may contain as much as 10 per cent. of the weight of the treated wood. The solution of this problem

opens up many scientific questions: From what portion of the ligneous substance are the organic acids derived? Is the process an hydrolysis? Above all, what is wood? And if in the course of our researches we take up those which refer not only to the mechanical pulp of brown wood, but also those which concern the white mechanical pulp, how is it that the paper made from mechanical wood-pulp turns brown so quickly? And how shall we determine the amount of wood in a mechanical pulp when it is mixed with other fibrous substances? Quite recently Messrs. Cross and Bevan have answered this question by an approximate solution. A solution of phloroglucin in hydrochloric acid gives a beautiful purple color to wood, which has long been used for the colorometric determination of the quantity in mechanical wood-pulp. But the two English savants have found that, as well as this color reaction, there is a notable absorption of phloroglucin by the wood-pulp, in fixed proportions by weight. If wood-pulp, or a substance containing wood-pulp, is placed in a solution of phloroglucin of known strength, and at the end of a certain time the then strength of the solution is determined, the quantity of phloroglucin consumed allows a conclusion to be drawn as to the amount of wood in the pulp.

The absorption of an inconsiderable quantity (6 to 7 per cent.) of phloroglucin by lignin, led Cross and Bevan to recognize in this fact a proof that only the ketone compounds and not the aldehyde compounds act in this way, for the aldehyde compounds will have been oxidized by the chlorine and could not give this reaction. This assumption, formulated by the English scientists, on the presence of compounds reacting in the lignin, leads us to recognize quickly the hypotheses which have been made on the subject of lignin. Scientists are agreed in admitting that there must be an aromatic nucleus in lignin. Czapek, by heating saw-dust (wood shavings) in water under pressure, obtained a substance which he called *hadromal*, which was recognized later, thanks to the work of Graefe, as being a mixture of vanillin, methyl furfurol, and pyrocatechin. Graefe concluded that from the quantity of methoxy compounds in the wood the quantity of vanillin could be deduced, and further that this must be the chief constituent of lignin. It is not necessary, however, that all the methylic compounds should

produce the vanillic nucleus, as Fromherz has shown. Moreover, it appears very probable, according to the recent researches of Klason, that lignin is composed of coniferyl alcohol (a compound closely related to vanillin) and of a derivative of this alcohol, oxyconiferyl alcohol, for four similar nuclei have been formed by separating the water. This constitution would be allied to that of the carbohydrates and should be of the same character as a glucoside. In fact, when water acts upon wood, a solution is obtained containing 10 to 12 per cent. of a wood-gum, which is a carbohydrate, from which proportion the content of lignin is deduced as 26 to 30 per cent. It is remarkable that invariably only 1.4 per cent. of carbohydrate is found in the residual lyes of the bisulphite process: it must be admitted then that the pressure, the rise in temperature, and the chemical agents have a destructive action. Let us remark, in passing, that it is possible after that to answer the question so many times asked, whether it is not possible to manufacture vanillin by utilizing either the residual lyes derived from the hot process of making wood-pulp or the lyes from the bisulphite process. At the very low price of $4.55 per pound, which is the present price of vanillin, no one would be interested sufficiently to make the extraction. Besides, it must first be considered that the demand for vanillin is not so important now, and that if this question was solved, it would not solve the problem of utilizing not only the cellulose but also the lignin of wood.

These considerations have led us face to face with that problem of the cellulose industry which is the most difficult to solve and at the same time the most important. What will become in the future of those innumerable organic substances dissolved in water, when our rivers refuse to accept them; or what will remain, even of the business itself, when the laws protecting water-courses, threatening even now, become active, and forbid us to throw the residual lyes into them in such large quantities as has been done up to the present time? The quantity of organic matter dissolved in water is nearly equal to the 564,000 tons of cellulose, and a means must be found of destroying it.

Having given the outline of this discussion, it is impossible to detail the numerous processes which have been suggested for the utilization of the residual lyes. However, that attention may be called to the most recent of the processes in this direction,

it will suffice to mention the one now on trial at Langen in Hesse. By heating the residual lye from the chemical wood-pulp of the bisulphite process in the presence of acids and, when required, applying pressure and adding formaldehyde, a tough and plastic body precipitates. The question now is to ascertain if this product really has such desirable properties as will allow of its use in such a way as to assure a large demand for it. This product may be considered as cellulose pitch. This is the name given to the product obtained at Walsumam Niederrhein by evaporating the residual lyes nearly to dryness, and has proved to be an excellent agglutinant for the agglomeration of powdered minerals. The whole question lies in knowing if, in such a case, the cost of evaporation would not be too great, in which event the process is of no value from an economic point of view.

In the production of cellulose by soda, the residual lyes need not cause any uneasiness. These lyes are concentrated and then calcined to extract the alkali contained in them.

In this case the organic matter which the lyes contain partly furnishes the fuel necessary for their recovery. On the other hand, to compensate for the absence of the problem of how to get rid of these residual lyes, this process has one great drawback, which explains why it is not more frequently adopted; the treatment of these residual lyes sets free very noxious fumes, which, up to the present, cannot be avoided. This inconvenience and the small yield of cellulose are the reasons for the abandonment of this process in Germany. At this moment, laws are being prepared in Scandinavia, with a view to the total suppression of the noxious fumes from this manufacture, and thus the existence of the industry of making cellulose by the soda process is strongly menaced in those countries.

But the utilization or the suppression of the residual lyes are not the only important problems. Cellulose, whether obtained by boiling with alkalies or from an acid solution, must be bleached. This does not mean merely to destroy the very slight color of the chemical pulp of heated wood, but rather to carry out an operation, which is a true chemical attack accompanied by a great loss of weight (4 to 10 per cent. in the case of bisulphite cellulose). There is no doubt that the discoloration would be much more intense and much more difficult to destroy

in the case of caustic soda cellulose than it is with bisulphite cellulose. We do not know the nature of the color; besides this problem has remained unsolved in another industry, the elder sister of the cellulose industry, the manufacture of cotton, for the coloring matter which causes the discoloration of raw cotton is not clearly recognized; it is only known that it seems to act as a caustic, a destroyer. As it seems to us, instead of completing the treatment by bleaching, it should be asked if the bleaching cannot be done during the treatment? Experience has taught that if the treatment is pushed too far the quantity and quality of the product are influenced to a considerable degree. The treatment should be considered as a sort of hydrolysis, so that on continuing it too long, not only the lignin, but also the cellulose itself is attacked. Thus in the soda process, it must be admitted that after the solution of the compound (analogous to an ether) which is formed by the cellulose and the lignin, the lignin is changed into lignic acid by the alkali, for Lange obtained not only cellulose, but also a certain quantity of lignic acid, by fusing wood and alkali together. The theories that have been suggested as to the reactions in the bisulphite process are very diverse: whether the acid radical of the sulphurous acid remains in the state of a double salt; or whether it reacts with the aldehyde compounds; or again whether it forms ethers or sulphonated acids. The last view is the one most accepted, thanks to the work of the Tollens laboratory, in fact the presence of a sulphonated acid combined with the lignin, has been recognized in the residual lyes of the bisulphite process; and from this compound, though with great difficulty, by means of alkalies, a sulphonated acid has been separated at the same time as a lignic acid, apparently identical with that obtained from the soda process.

It seems to us that these considerations only concern lignin. But what can we say relatively about cellulose? Is there really a unique cellulose which is isolated when the boiling is not continued too long? Are there fixed quantities of a less stable cellulose which go into solution? It is certain that this is the case in the soda process of making cellulose; in fact the yield is 15 to 25 per cent. less than that obtained in the bisulphite process, and the product even after bleaching does not always appear identical with cellulose from cotton; for among other

distinctions it reacts with phenylhydrazine, and forms furfurol when distilled with hydrochloric acid. Are these reactions due to the existence of a mixture of several different celluloses? or are they due to a *single* cellulose? or again are they due merely to impurities, difficult to remove? What will remain when these impurities are eliminated? It is plain there is no lack of unsolved questions and that all of them, more or less, await their solution by work based on experiment. But that is not all: the different kinds of cellulose formed during the boiling show still more subtle differences and present an immense field for purely chemical research, for, up to the present time, the various kinds cannot be completely differentiated by their physical properties. There are certainly different kinds of cellulose pulp obtained, according as they are treated by slow boiling as in the Mitscherlich process, or by rapid boiling as in the Rittner-Kellner process.

Are all these different hydrates one and the same cellulose like that of cotton? These questions remain for the most part unanswered. Only one of the questions relating to the carbohydrates has as yet received a reply. It is now known, at least, that by excessive treatment of the bisulphite cellulose, a transparent substance is obtained, looking like parchment externally, and quite comparable to vegetable parchment, which has been called *pergamyn*. But pergamyn is not a cellulose hydrate, but rather a cellulose boiled to the condition of boiled (sodden) rags, and from a chemical view-point is clearly distinguished from the hydrate, which is vegetable parchment by the reagents iodine and potassium iodide; the parchment alone, a cellulose hydrate, becomes blue.

Up to now we have only spoken of wood and of the cellulose extracted from it. Without going farther, other problems present themselves when the different ligneous essences are considered as subjects for research: how to recognize the different kinds of wood and the celluloses they yield; the evergreen woods such as pine and fir, and the wood with decaying foliage, of which those chiefly used are the poplar, the birch, and the beech. Every kind of cellulose produced from these different woods should be clearly distinguished.

Besides wood is not the only raw material which produces cellulose. Cellulose can be extracted from other ligneous fibres,

particularly herbaceous plants. In Germany it is made from wheat and rye straw, in England and in the rest of continental Europe from esparto grass or alfalfa. This last can be disintegrated by a fermentation analogous to the steeping of flax, but the soda process is principally used. This process only is applied to straw. When the sulphate process is used, *i.e.*, the process when the work of sodium hydrate is completed by sodium sulphate, a 42 per cent. yield of a cellulose is obtained, which from its reactions should be considered as an oxycellulose, although it is not as yet very thoroughly understood. In spite of its comparatively weak mechanical resistance as compared to bisulphite cellulose, it furnishes a raw material very applicable for manufacturing letter paper. The problem of the residual lyes is the same as in the case of boiling wood with soda. Really, in the recovery of the alkali, the most interesting question is that of the noxious fumes; but the lyes also doubtlessly contain substances of considerable alimentary value, and further, substances which are gelatinous and have a certain coloring power, of such a kind as to offer one more reason for attempting to utilize these lyes in an advantageous manner.

The considerable development of the manufacture of cellulose, both from wood and straw, gives rise to the fear of a dearth of raw materials in the future. Thus the German cellulose factories are already treating wood brought from the shores of the White Sea. If the devastation of the forests should progress rapidly in the northern countries, the cellulose industry will be stopped by the want of raw materials. There is so much the more reason that our country should be able to furnish the quantity of wood demanded by the industry. Besides, the available quantity of straw is very limited. The indigenous plants which should furnish large quantities of fibre suitable for paper making are not at our disposal, for the hope of converting turf into a fibre utilizable for paper has proved deceptive. Since considerable capital has been swallowed up in attempts to effect this, it would appear prudent to give it up completely. In any case there still remain reeds; but only for our Austro-Hungarian neighbors. In fact it seems that in the delta of the Danube and in the lower Danube region, reeds are found from which there can be successfully extracted a cellulose analogous to that from straw. In any case it must

not be forgotten that the quantity of available fibre here is not very large. Hence for the future of paper-making in Germany, we must look to our colonies.

For the moment let us imagine that plants could be treated where they grow, in some way so as to decrease as much as possible the dead weight for transportation, and could be sent to Europe in a half-prepared condition. According to information from an English origin, in Burmah alone there are 60,000 square miles covered with bamboo jungles close to navigable rivers. Granting the rapid growth of these plants, it has been calculated that an area of 16 square miles would be enough to furnish the raw material necessary to make 100 tons of paper per week. It follows that Burmah, that small part of India, would alone suffice to furnish as much cellulose as the whole world demands. The scarcity of wood, however, is not yet so pressing that there is any need to introduce the cellulose manufacture in countries with a murderous climate, to consume enormous capital, and to expose it to the difficulties of considerable hand-labor. From this point of view America is much better off. Putting aside the fact that in this country it is still possible to devastate the forests on a large scale, instead of having recourse to the creation of a new industry, the short fibres which adhere to the cotton bolls can be used, and the residues and waste of raw cotton, about 600,000 tons of raw material; further, there is still available about 22,000,000 tons of cotton stalks, which have been hitherto considered of no value and are buried by the plow every year. At the same time, and in an analogous manner, the maize stems, wild hemp, marsh herbs, and wild rice are wasted. Some of these American sources already feed the German paper industry. Thus the factories at Bremen treat cotton, utilizing the fibres sticking to the cotton bolls and using them to prepare a product commercially sold under the name of Virgo fibre (thread).

Another very important industry, and to an extent closely allied to the cellulose industry, has also developed greatly: that of artificial silk. That, too, uses cellulose as the raw material. The total natural silk in the world is estimated at 50,000,000 kilograms (110,000,000 pounds) worth $350,000,000; the production of artificial silk has reached 5,000,000 kilograms (11,000,000 pounds) worth $20,000,000. Although

the use of natural silk has not yet diminished in favor of artificial silk, the foregoing figures show the growing importance of this new and quite young industry; quite young for it only began in 1880.

In the beginning cotton cellulose was the only thing they dreamed of using. This cellulose was treated with nitric ether (*sic.* nitric *acid?*), the product thus obtained was dissolved in a mixture of alcohol and ether, and the solution transformed into thread, which, by the use of reducing agents, such as calcium sulphide, was rendered uninflammable. Soon, however, a second process came into use, which consisted in dissolving cotton cellulose in a cupro-ammoniacal solution, spinning this solution, and coagulating it by means of acids or bases. A third process, the production of viscose silk, has lately been added to the preceding ones.

But the development of this industry has not answered to its early promise on account of the high price of its raw materials, viz.: wood cellulose, carbon bisulphide, and soda lye; in fact the manufacture is much too difficult. It is only after 12 years of efforts that the scientists Cross and Bevan succeeded in making the process practical, and thoroughly mastered what they termed the "maturing" of the viscose. Really, when the three processes were yet in the midst of their development, they encountered a fourth and most serious competitor which came on the scene, although it is true that no marketable product of this process seems yet to have appeared in commerce, that is, silk from cellulose acetate.

While the three kinds of artificial silk mentioned earlier contained only cellulose, regenerated in different ways, in this case the finished thread contained an acetic ether of cellulose. This ether is insoluble in water and, moreover, preserves its mechanical (physical) resistance in presence of water, a quality to which the other artificial silks cannot pretend, except in a very limited degree. The artificial silks from nitrocellulose, from ammoniacal copper, and viscose silk are in themselves less substantial than natural silk, but when they are damp they lose a great deal of the little resistance they possess. This drawback, of preponderant influence, has already made itself felt in dyeing, but it makes itself felt still more during weaving, when the fibres come in contact with water or with damp air.

Silk from the acetate does not suffer from exposure to humidity. At first great difficulty was experienced in dyeing because aqueous solutions of coloring matters would not penetrate the fibre, but by using agents which swelled the fibre these difficulties were overcome. There is no need to enlarge on this subject because a short time ago Professor Knævenagel enlightened us as to the tinctorial properties of acetylcellulose in a very interesting lecture, with experiments, that he gave at Heidelberg at the reunion of the Association of South German Chemists.

All that has been previously said as to the chemical difficulties applies also to the conditions in which the acetate is produced. The use of acetic anhydride and a little sulphuric acid at the same time, results in the very great instability of the ethereal solutions thus obtained, and this causes more or less fragility of the threads or films which have been produced. Now these difficulties are avoided by various methods. In Knoll & Co.'s patents we find sulphuric acid replaced by benzolsulphonic acid as suggested by Knævenagel, as well as the addition of neutral salts to the alkaline salts used as regenerators. The effects of these modifications are: to stop hydrolysis which is not desirable, to prevent the destruction of celluloses of large molecular weight, and to obviate any ulterior modification of the physical properties of the product obtained. Aside from the solution of this problem, an appropriate solvent has also been sought for several years. Now acetone and acetic ether have become the regular solvents, while formerly no one dreamed of using anything but chloroform, glacial acetic acid, or analogous liquids, which made the practical use of cellulose acetate very difficult. Thanks to the kindness of Professor Knævenagel and the firm Messrs. Knoll & Co., I am enabled to show you here some samples of cellulose acetate and of artificial horse-hair, the production of which is still in the experimental stage. At the same time, I can show you, thanks to the kindness of the color manufacturers, Messrs. Frederic Bayer & Co., a fine collection of sensitive preparations with a cellite (cellulose acetate) base. As you have already learned at our general meeting at Jena something of cellite films, it appears that the problem of the inflammability of kinematograph films (hitherto made of celluloid) has been entirely solved.

The destruction of the cellulose molecule pushed too far during the etherification referred to above, is the cause of great difficulties, not only in the production of acetate, but also in that of Chardonnet's Glanstzoff silks, and of viscose silk, which should be included; in fact, during the regeneration of cellulose, not only cellulose but also a cellulose hydrate is produced. This hydration must be considered as the reason for the weak mechanical resistance of the thread in the presence of water. According to Eschalier, this inconvenience can be avoided by treating viscose with formaldehyde in acid solution. Eschalier is convinced that formaldehyde induces the spontaneous reconstruction of the molecule previously destroyed. According to his figures, the mechanical resistance of viscose silk thus treated is increased in a considerable degree. There still remains the question whether, in spite of the increase in solidity, the elongation (extension) is still sufficient; for it is the low value of these two properties which has hitherto so unfavorably distinguished artificial silks from natural silks. The most important problem in the industry of artificial silks that still remains to be solved is that of endowing them with these two properties.

There is still to be mentioned the complication of questions relating to cellulose hydrates, found in Knecht's recent work on mercerized cotton. He shows that the absorbent power of cotton differs remarkably according to whether during mercerization, it has not been dried at all, or has been dried; and if dried, whether this has been done at the ordinary temperature or at 100° C. Hence different methods of drying give rise to different hydrates. Also Berl states that if cotton is heated in a current of inert gas at a high temperature, it undergoes polymerization which exerts a favorable influence on the properties of the resulting nitrocelluloses.

These considerations make it sufficiently clear that in the cellulose industry and its allied industries, in spite of the numerous isolated observations, the characteristics of cellulose or the celluloses are very imperfectly known from the chemical point of view. We do not even know the constitution of the cellulose of cotton, which may be taken as the type, and still less of its derivatives—the cellulose hydrates, the hydrocelluloses, and the oxycelluloses. We can only form a vague idea of

these bodies. If the cellulose industry is to continue to progress, it is absolutely necessary that a systematic study be made of all the bodies included in the above category.

An advance in the study of their constitution can generally be effected either by the synthesis or the analysis (destruction) of these bodies. There can be no question at present of constructing a molecule of cellulose, but by destroying an apparent molecule, a certain enlightenment seems to have been obtained. By making decomposition products, we have only a very superficial idea of the cellulose hydrates, but we already know a little more about the hydrocelluloses; we specially know, thanks to Tollens, that when the oxycelluloses are heated with milk of lime (calcium hydrate) they yield dioxybutyric acid and isosaccharic acid; we know that they form sugar by hydrolysis in an acid solution, and by the same method a body representing an intermediary state of transformation between sugar and cellulose—cellobiose.

The theory based on the figures representing these decompositions would be very fruitful, and would be still more so if the researches were made under similar conditions on the large number of celluloses that can be isolated from wood and herbaceous plants. It is highly probable, however, that resort must be had to new methods of research. The future will tell us if these new methods should to some extent encroach on the boundaries of the chemistry of the colloids. In spite of the splendid results found in the domain of the chemistry of the inorganic colloids, it seems as if the organic colloids, cellulose amongst them, would escape from disclosing the secrets of their constitution like so many colloidal substances. Whether it be by purely chemical methods, or by physicochemical methods, there is no doubt, in any case, that those who devote themselves, regardless of the labor, to such serious experimental reseaches, will have greatly accelerated the progress of the chemistry of cellulose as well as that of pure science, and that the progress of the cellulose industry will likewise be facilitated.

# COMPARISON OF THE DIFFERENT METHODS OF MEASURING THE DI-ELECTRIC CONSTANT.

BY

M. PAUL FLOQUET.

(Translated from *Comptes rendus*, cli, No. 11, by W. J. Williams, F.I.C.)

THE di-electric constant is measurable by very diverse methods, generally giving discordant results. This is explicable, when it is considered that the different formulas used for this purpose are based on the supposition that a perfect di-electric is used. Since M. Malclès has shown that the hard paraffin extract of ozokerit has no residual charge at the ordinary temperature, has lost all appreciable conductivity, and therefore seems to be a perfect di-electric, I have sought to obtain really concordant values by applying different methods of measuring the di-electric constant to this paraffin.

After proving the absence of any residual charge and of conductivity in the paraffin used, at first I chose an arrangement which enabled me to compare the values of the di-electric constant obtained by two different static methods at the same time. Between the two brass cylinders of one of Messrs. Bichat and Blondlot's absolute electrometers, a hollow cylinder of paraffin is placed, suspended from the beam of a balance. This cylinder has the same axis as the cylinders of the electrometer and its lower extremity is placed almost at mid-height of the space common to the two cylinders.

By using the balance of the electrometer, I measure the attraction $F'$ of the movable metallic cylinder; on the other hand by the help of the second balance I determine the attraction $F''$ of the paraffin cylinder.

I then take out the paraffin, and for the same difference of potential $V$, determined by a very sensitive guage, I find the attraction $F$ of the movable cylinder of the electrometer.

The values of $F$ and $F'$ on one hand, and of $F$ and $F''$ on the other, enable us to find the value of the di-electric constant $K$. The following formulas, easy to calculate, are used:

$$F = \frac{V^2}{4} \frac{1}{L\frac{R}{r}},$$

$$F' = \frac{V^2}{4} \frac{1}{L\frac{R}{r} - \left(1 - \frac{1}{K}\right) L\frac{R'}{r'}},$$

$$F'' = \frac{V^2}{4} \left[ \frac{1}{L\frac{R}{r} - \left(1 - \frac{1}{K}\right) L\frac{R'}{r'}} - \frac{1}{L\frac{R}{r}} \right],$$

where $R$ is the radius of the exterior cylinder of the electrometer, $r$ the radius of the interior cylinder, $R'$ the external radius of the paraffin cylinder, $r'$ its internal radius. It should be noticed that $F'' = F' - F$, and if $F$ is known, an absolute value for the difference of potential used can be found.

The measurements were first taken with a constant difference of potential $V$. Under these conditions there occurred a phenomenon which disturbed the measurements, although the paraffin used might be considered as a perfect di-electric.

Immediately after the establishment of a constant field in the electrometer, a progressive diminution of the attractions $F'$ and $F''$ is observed. I have proved that this diminution is due to the appearance, on the surfaces of the paraffin cylinder, of charges of the same sign as those of the opposite armatures; the charge on the internal surface being of greater absolute value than that of the external surface. The speed with which the attraction diminishes is very variable from one day to another. Observation of the spontaneous discharge of an electroscope placed in the laboratory has enabled me to ascertain that the perturbation was greater the more rapidly the electroscope lost its charge. Accordingly the parasitical charge of the paraffin cylinder can be attributed to the existence of electrified centres in the air of the laboratory.[1] These are displaced by the action of the electric

[1] Langevin: Bulletin des Séances de la Société de Physique, 4th fasc., 1904, p. 67.

force and deposit themselves on the surface of the paraffin. Analogous phenomena have been pointed out by Messrs. Crémieu and Malclès [2] who observed a progressive diminution of the electrostatic influence through an isolating plate. I have observed that brush discharges, or X-rays sent through the field of an electrometer, produce the same effect, but with much greater intensity.

Days occur when the atmospheric ionization is so weak that the paraffin does not acquire any appreciable charge. At such times precise measurements can be taken. It is useful to remark that the error introduced by atmospheric ionization into the measurements of the di-electric constant by static methods, is in a sense inverse to the error caused by conductivity or by residual charges.

The same measurements with the same apparatus were again taken, using alternative potentials with a frequency of 50. In this case the values of the attractions are strictly invariable. The results deduced agree with those obtained by the static method on those days when the effects of the atmospheric ionization are negligible.

Measurements were made with cylinders of different dimensions.

Table I gives the results obtained for cylinders of different radius.

TABLE I.

| Potentials, volts | Attraction in milligrammes | | | | Dielectric constant determined by | |
|---|---|---|---|---|---|---|
| | $F$ | $F'$ | $F''$ | $F'-F$ | $F'$ | $F''$ |
| 5300..... | 790 | 955 | 165 | 165 | 2.288 | 2.288 |
| 18900..... | 1005 | 1215 | 211 | 210 | 2.290 | 2.302 |
| 21700..... | 1208 | 1460 | 255 | 252 | 2.285 | 2.314 |

$R = 48.70$ mm.; $r = 17.45$ mm.; $R' = 37.71$ mm.; $r' = 27.52$ mm. The values of $K$ were determined approximately to the one-hundredth. It is obvious they are concordant. Further,

[2] V. Crémieu et L. Malclès: Comptes rendus, Nov. 14, 1904, p. 790; and L. Malclès, Thèse de Doctorat.

they agree with the value 2.30 as determined by Macles [3] using a static method.

Then I used a completely different method, which consists of measuring the ratio $n$ of the speed of propagation of the Hertzian waves in air and in paraffin. Blondlot [4] has shown that in the case of Maxwell's relation, $n^2 = K$, is rigorously applicable. The measurements were made by observing the retardation effected in the waves during their passage through a copper wire 179 cm. long, sunk in paraffin. I used the method which Gutton [5] applied to the determination of the di-electric constant of ice. Working with different lengths of wave, the results shown in Table II were obtained.

TABLE II.

| Length of wave, cm. | Retardation, cm. | Index of refraction | Di-electric constant |
|---|---|---|---|
| 36 | 92 | $n = 1.514$ | $K = n^2 = 2.292$ |
| 50 | 91 | $n = 1.508$ | $K = n^2 = 2.275$ |
| 100 | 91 | $n = 1.508$ | $K = n^2 = 2.275$ |

The values of $K$ were again determined approximately to the one-hundredth. They agree with those given by the method of slow oscillations and the purely static method.

It is again obvious that, with the paraffin used, the dispersion of the electromagnetic waves appears very slight and does not introduce any notable difference between the values of the di-electric constant whether relative to slow oscillations or to very frequent oscillations.

[3] L. Maclès: Thèse de Doctorat.
[4] R. Blondlot: Comptes rendus, 1892, No. 5, cxv, p. 225.
[5] C. Gutton: Comptes rendus, 1900, No. 5, cxxx, p. 1119.

# FRANKLIN INSTITUTE

*(Proceedings of the Stated Meeting, held Wednesday, October 19, 1910.)*

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, Oct. 19, 1910.

*President* MR. WALTON CLARK *in the Chair.*

Additions to membership since last report, 9.

Mr. E. E. Watson, Factory Inspector, Herring-Hall-Marvin Safe Company, Hamilton, Ohio, presented a communication on "Recent Advances in the Construction of Fire and Burglar-Proof Safes."

The speaker gave an interesting account of the progress made in the construction of locks and the building of burglar and fire-proof safes. He described the various kinds of locking devices from the latch lock to the most recent form of changeable-key lock. Mention was made of the various types of safes constructed during the past century, special attention being given to those in use to-day. At the close of the paper the thanks of the meeting were extended to the speaker and the subject was referred to the Committee on Publications. Adjourned.

R. B. OWENS,
*Secretary.*

## COMMITTEE ON SCIENCE AND THE ARTS.

*(Proceedings of the Stated Meeting held Wednesday, October 5, 1910.)*

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, October 5, 1910.

MR. THOMAS SPENCER, *in the Chair.*

The following report was presented for final action: (No. 2480) Reeves Variable Speed Transmission. (Advisory, adopted.)

No reports were presented for first reading.

R. B. OWENS,
*Secretary.*

## SECTIONS.

*Electrical Section.*—A meeting of the Section was held on Thursday evening, October 6, 1910, at eight o'clock; fifty members and visitors present. The meeting was called to order by Mr. Thomas Spencer, Chairman of the Section. In the absence of Mr. Joseph Appleton, who was unavoidably detained in Chicago, his paper on "Some Recent Problems in Storage Battery Engineering" was read by the Secretary of the meeting. The use of the storage battery in modern industrial establishments was described and results of its operation as an adjunct to power-generating plants were shown.

The subject was discussed by Dr. Goldsmith, Mr. Tracy, the Chairman, and others. Adjourned.

ALFRED RIGLING,
*Acting Secretary.*

*Mechanical and Engineering Section.*—A meeting of the Section was held on Thursday, October 13th, at eight o'clock. Dr. W. J. Williams, temporary Chairman. Eighty members and visitors present.

After reading of the minutes of the previous meeting, the Chairman introduced Mr. J. A. P. Crisfield, Engineer of Construction of the United Gas Improvement Company, Philadelphia, who presented a paper on the "Mechanical Engineering Problems in Illuminating Gas Works." The speaker referred to the most important problems which the mechanical engineer is compelled to solve in the modern plant of a gas works. The subject was illustrated by numerous lantern slides.

After a brief discussion the thanks of the meeting were extended to the speaker.

ALFRED RIGLING,
*Acting Secretary.*

*Mining and Metallurgical Section.*—A meeting of the Section was held on Thursday evening, October 20, 1910, at eight o'clock.

The meeting was called to order by the President of the Section, Prof. A. E. Outerbridge, Jr.

Fifty members and visitors were present.

The Chairman introduced Mr. Henry Souther, President of The Souther Engineering Company of Hartford, Conn., who presented a communication on the "Selection and Treatment of Alloy Steels for Automobiles." The speaker called attention to the necessity of selecting steels which will do most efficiently the work for which they are intended. The various grades of steel were described and reference was made to their composition.

After a brief discussion Prof. Outerbridge presented his annual address as President of the Section on the "Integrity of Tests of Metals." As this has already been printed (see this JOURNAL, clxx, 206) it was read in abstract only. Lantern slides of cross-sections of various metals and test-bars were shown and described and specimens of test-pieces were passed among the audience for examination.

The thanks of the meeting were tendered to the speakers and Mr. Souther's paper was referred to the Committee on Publications. Adjourned.

ALFRED RIGLING, *Acting Secretary.*

# FRANKLIN INSTITUTE

## MEMBERSHIP NOTES.

### Elections to Membership.

LIFE.

EDW. V. McCAFFREY, Manufacturer, Fifth and Berks Sts., Phila.
JAMES G. DAVIS, Mech. Engineer, The U. G. I. Co., Broad and Arch Sts., Phila.

RESIDENT.

JOHN MORRIS WEISS, Chemist Barrett Manufacturing Co., Frankford, Phila.
WALTER DILKS, 1102 Chestnut St., Phila.
R. NORRIS WILLIAMS, 8124 St. Martin's Lane, Chestnut Hill.
J. A. STEINMETZ, Iron and Steel, Central Trust Co., Fourth and Market Sts., Phila.
WILLIAM H. BALLS, Teacher, 5120 Greene St., Germantown, Phila.
JOSEPH S. HEPBURN, Chemist, 1833 Chestnut St., Phila.
S. PRICE STEVENSON, Manufacturer, Chester, Penna.
WARNER G. EARNSHAW, Bituminous Coal, Harrison Bldg., Phila.
NORMAN MACBETH, Illuminating Engineer, Weightman Bldg., Phila.
HENRY A. GARDNER, Chemist, Paint Manufacturers Assoc., 3500 Grays Ferry Road, Phila.
JOHN J. GIBSON, Elec. Engineer, 115 So. Broad St., Phila.
JOSHUA A. PEARSON, Purchasing Agent, The U. G. I. Co., Broad and Arch Sts., Phila.
E. R. KNOEDLER, Asst. to Gen. Manager, Welsbach Co., Gloucester, N. J.

NON-RESIDENT.

ENRIQUE CRUCHAGA OSSA, Calle de Castro No. 49, Santiago de Chile, South America.
L. AKESSON-AMREIN, Manufacturer, Zurich, Switzerland.
GEORGE C. REESE, Manufacturer, 247 East Twenty-first St., New York City, N. Y.

ASSOCIATE.

ANDREW W. HILL, Steam Heat and Ventilation Estimator, 1917 South Broad St., Phila.
CHARLES HUBSCH, Draughtsman, 1515 W. Passyunk Ave., Phila.

### Changes of Address.

M. DE TEIVE E. ARGOLLA, Caixa Postal 226, Bahia, Brazil.
FRANK HEPBURN, care British Vice-Consulate, Mutual Life Bldg., Jacksonville, Fla.
FRANK ANDERSON, 468 Twelfth East St., Salt Lake City, Utah.
HIRAM W. HIXON, 251 So. Forty-first St., Phila.
DR. E. J. HOUSTON, 1701 Chestnut St., Phila.
RALPH D. MERSHON, 60 Wall St., New York City.
CHARLES KIRCHHOFF, Rhineland Court, 244 Riverside Drive, N. Y.
WILSON E. SYMONS, 900 Postal Telegraph Bldg., Chicago, Ill.
GEORGE A. GREVEMEYER, 223 Walnut St., Phila.
E. STUTZ, 306 West Eighty-second St., New York City.

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## LIBRARY NOTES.

### Purchases.

KRAHMANN, M.—Fortschritte der praktischen Geologie und Bergwirtschaft.
OSTWALD, W.—Die Energie.
LÜPPE-CRAMER.—Die Röntgenographie in ihrem photographischen Teil.
VOIGT, W.—Magneto- und elektrooptik.
RICHARZ, F.—Anfangsgründe der Maxwellschen Theorie.
GOCKEL, A.—Die Luftelektrizität.
STOLZE, F.—Panoramenapparate in ihren Vorzügen und Mangeln.
PLOTNIKOW, T.—Photochemie.
HANN, J.—Handbuch der Klimatologie. 2 vols.
WINKELMANN, A.—Handbuch der Physik. 6 vols.
MÜLLER-POUILLET.—Lehrbuch der Physik. 4 vols.
LIESEGANG, F. P.—Handbuch der praktischen Kinematographie.
PÖSCHL, V.—Die Härte der festen Körper.
MAURAIN, CH.—Les Etats physiques de la Matiere.

### Gifts.

U. S. Coast and Geodetic Survey. Results of observations made at the Magnetic observatory at Vieques, Porto Rico, and Baldwin, Kansas, in 1905 and 1906. Washington, 1910. (From the Survey.)
Sydney University Engineering Society, Proceedings, volume 14. Sydney, 1910. (From the Society.)
Great Britain, Labour Department. Report on Changes in rates of wages and hours of labour in 1909. London, 1910. (From the Board of Trade, Labour Department.)
Boston and Maine Railroad. Report 1909-'10. Boston, 1910. (From the Railroad.)

St. Louis, Mo., Water Commissioner, Annual report. St. Louis, 1910. (From the Commissioner.)

Illinois Bureau of Labor Statistics. 28th annual coal report, 1909. Springfield, 1910. (From the Bureau.)

Der Ausban der Niederdruckwasserkräfte, von Adolf Ludin. Heidelberg, 1910. (From the Technical High School, Karlsruhe.)

McGill University, Matriculation Examination results. Reports and papers. Montreal, 1910. (From the University.)

New York State Library, Bibliography bulletin No. 4. Albany, 1910. (From the University.)

Northampton Polytechnic Institute, Announcements 1910–1911. London, n.d. (From the Institute.)

Western Australia Mines Department. Report on the state of mining progress in certain centres in the Marchison and Peak Hill goldfields, by A. Montgomery. Perth, 1910. (From the Department.)

Great Britain, Labour Department. Report on strikes and lock-outs in the United Kingdom in 1909. London, 1910. (From the Board of Trade, Labour Department.)

U. S. Brewers' Association. Proceedings of 50th annual convention. New York, 1910. (From the Association.)

India Geological Survey. Memoirs. Palæontologia Indica, new series, vol. 3, Memoir No. 1. Calcutta, 1909. (From the Survey.)

Illinois Geological Survey. Bulletin No. 15. Springfield, 1910. (From the Survey.)

U. S. Geological Survey. Bulletin No. 425. Washington, 1910. (From the Survey.)

North Carolina Geological and Economic Survey. Economic paper No. 19. Raleigh, 1910. (From the Survey.)

Königlich-Technische Hochschule zu Hannover. Programm, 1910–1911. Hannover, 1910. (From the High School.)

Nova Scotian Institute of Science. Proceedings and Transactions, vol. 7. part 2. Halifax, 1910. (From the Institute.)

Lynn, Mass., Public Water Board. Annual report for 1909. Lynn, 1910. (From the Board.)

Meteor Crater in Northern Central Arizona, by D. M. Barringer. (From the Author.)

New South Wales. Official Yearbook 1908–9. Sydney, 1910. (From the Government Statistician.)

# BOOK NOTICES.

NOTIONS FONDAMENTALES SUR LA TELEGRAPHIE. Envisagee dans son developpement, son Etat actuel et ses Derniers Progres. (Du Breguet au Pollak et Virag et aux Telephotographes.) Par Albert Turpain, Professeur de Physique á la Faculte des Sciences de l'Universite de Poitiers. 180 pages, 9 x 6 inches, with 122 figures. Price 5 francs.

TELEPHONIE DU TELEPHONE BELL AUX MULTIPLES AUTOMATIQUE. Essai sur les origines et le Développement du Telephone. Par Albert Turpain, Professeur de Physique á la Faculte de l'Universite de Poitiers. 186 pages, 9 x 6 inches, paper with 123 figures. Price 5 francs. Bibliotheque de l'Elévè-Inginieur. Gauthier-Villars, Paris, 1910.

These monographs are components of a series designed for the engineer-student. The subject-matter is mainly descriptive, theoretical considerations being dwelt upon but briefly.

The work on telegraphy is treated under the divisions (1) Simple Telegraphy, relating to apparatus in present common use. (2) Rapid Telegraphy, and (3) The Future of Telegraphy.

In the work on telephony the subject is introduced with a brief history of the development of the art. The various devices and applications of the usual plant are described in detail terminating with a chapter on the relative recent Strowger automatic system.

Both volumes are fully illustrated by well executed diagrams and cuts with annotations. They should prove very satisfactory works indeed for their intended purposes.

THE TELEGRAPHIC TRANSMISSION OF PHOTOGRAPHS. By T. Thorne Baker, F.C.S., F.R.P.S., A.I.E.E. XI, 146 pages, 7½ x 5 inches, 64 figures, cloth. D. Van Nostrand Company, New York, 1910. Price $1.25.

Although attempts at the transmission of pictures by telegraph dates as far back as the beginning of telegraphy itself, the problem has proved a difficult one and it is only within comparatively recent years that a reasonable measure of success has been attained. The author having been actively engaged in experimental work of this kind is especially qualified to carry out his purpose of collecting under one cover notes of interest relating to past experiments and recent achievements scattered in the files of the technical press. Considerable space is devoted to the description of two promising recent systems, one developed by Professor Korn, the other by the author. The work is of particular value in saving the labor of searching for original papers for information on the subject, a list of which would have materially added to the value of the book.

NOTIONS ELÉMENTAIRE SUR LA PROBABILITÉ DES ERREURS. Par Maurice d'Ocagne, Ingenieur de Ponts et Chaussées, Professeur à l'Ecole des Ponts et Chaussées. 27 pages, 9 x 6 inches, 2 diagrams, paper. Gauthier-Villar, Paris, 1910.

A casual glance over any of the numerous treatises dealing with the theory of probability of errors will satisfy anyone accustomed to technical reading that a study of the subject is not one to be undertaken in a trivial spirit. For that reason a serious student who might desire to learn the meaning of the formulas developed and their more simple application is often deterred from making the attempt. M. d'Ocagne's brief treatise will appeal strongly to such readers. It is a reprint of two lectures before the students of the French school of Bridges and Highways and embraces the principles of the subject as far as they may be applicable to measures of precision employed by engineers. Except in the elementary theory of probability, no attempt is made to derive the results presented and discussed at considerable length. In that respect the work is somewhat disappointing, notably in the omission of an analytical demonstration of the equation representing the probability of an error as a function of its magnitude. But a full demonstration of all the theorems embraced would many times multiply the compass of the volume and defeat the author's purpose to present briefly an outline of the subject and its applications.

LES COMPTEURS ELECTRIQUES A COURANTS CONTINUS ET A COURANTS ALTERNATIFS. Leçons Professees a' l'Institut Electrotechnique de Grenoble. Par L. Barbillion, Professeur a la Faculte des Sciences, Directeur de l'Institut, avec la Collaboration de G. Ferroux, Ingenieur, Charge de Conferences a cet Institut. Paper vii + 226 pages, 7 x 4½ inches, 126 diagrams. Gauthier-Villars, Paris, 1910. Price 3 francs 0.25.

The present volume is a contribution to a series of monographs on various topics of technical interest issued under the title "Actualities Scientifiques." Although an already well-trodden field is covered, it would be difficult to find a better presentation of the subject for study or a better arrangement for reference. The general principles and component elements of modern electric meters are set forth with but a passing mention of superseded and nondescript types. The work is divided into three chapters dealing respectively with continuous-current meters, alternating-current meters, and meters of special types to meet unusual conditions, closing with an appendix containing complete specifications and tests for meters prescribed by the Electrotechnical Institute of Grenoble.

Each of the numerous types presented is treated as a separate unit and in proper sequence, a feature of undoubted merit in a text-book. There are no illustrations of actual apparatus, but the well adapted line diagrams which illustrate the subject serve a better purpose. The text in precision and deductive clearness is excellent. The demonstrations are at once ample and concise and, what is better still, convincing. The work is clearly the product of master hands in the art of elucidation.

LA MÉTALLOGRAPHIE MICROSCOPIQUE. Par L. Révillon, Ingenieur des Arts at Manufactures. 176 pages, 7½ x 4½ inches with 24 figures, paper (Encyclopédie Scientifique des Aide-Mémoire). Gauthier-Villars, Paris, 1910. Price, paper, 2 francs 50; flexible cloth, 3 francs.

The microscopic examination of the structure of metals has in recent years become an accepted and highly valued mode of investigation in industrial technical laboratories. The appearance of a work dealing with the technic of the method as practised in the laboratories of the firm of Dion-Bouton,—a name synonymous with refinement in automobile construction,—of which the author is in charge, cannot fail to be cordially welcomed. The manipulations involved in the various operations are described in detail followed by an illustrated account of the results of examinations of many different metals and alloys illustrated by half-tone photographs. An appendix treats of the similar mode of examination without the use of the microscope and with a less careful preparation of the specimen by which means quite satisfactory conclusions may be drawn.

ELECTRICITY EXPERIMENTALLY AND PRACTICALLY APPLIED. A Book for the Beginner and for the Practical Man; Principles, Experiments, Practical Applications and Problems. By Sydney Whitmore Ashe, B.S., E.E., Author of "Electric Railways"; formerly Instructor in Physics and Electrical Engineering, Polytechnic Institute of Brooklyn. 349 pages, 12 mo., cloth. D. Van Nostrand Company, New York, 1910. Price $2.00 net.

Anyone of usual intelligence can learn something by purely experimental teaching and a great deal if the teaching is systematically carried on. No apology is, therefore, needed for a work which covers the subject in proper order from the fundamental elements of electromagnetism to its most elaborate application to current production and the transmission of power. The primary object of the work is to meet the needs of students recruited from the ranks of manufacturing establishments who have had little or no mathematical training and to aid those of the "self-taught" type by means of the full and well illustrated descriptions. A student who masters the contents of the book will seldom be at a loss in responding to demands of practical service.

NOTES ON MECHANICAL DRAWING. Prepared for the use of students in Mechanical Engineering at the University of Pennsylvania. By Horace P. Fry, B.S. in E.E., Asst. Professor of Mechanical Drawing. 60 pages, 6 x 9 inches, cloth, illustrated. Printed for the University, Philada., 1910.

Mechanical drawing has been characterized a universal language by whose aid the engineer may with the greatest possible brevity direct the embodiment of his ideas into a concrete form. The definition is appropriate enough for, with its development to meet the ever-increasing needs and refinements incident to industrial progress, it has like any other language in constant use acquired a corresponding variety of shades of expression and

meaning. At the present day more is required in professional draughtsmanship than a knowledge of the principles of projection and dexterity in drawing-board processes.

Notes on mechanical drawing covers just those features that mark the difference between a draughtsman qualified to meet the requirements of the factory drawing office and the draughtsman who knows how to draw but has yet to learn the knack of making drawings of commercial value.

It contains full instructions governing the procedure which the student is required to follow in prosecuting the several courses specified, and constitutes a code of practice which might with advantage be adopted in many commercial drawing offices. The instructions are precise and emphasized by the free and commendable use of bold-faced type at critical points. In great detail the student is shown, adequately illustrated, the very things which ordinarily he is expected to devise for himself, such as arrangement of views, dimensions, size and position of legends and title, for the best effect.

It is doubtful that any topic of material consequence has been omitted and if there is any occasion to disagree with some of the methods or recommended forms, such disagreement will arise from local requirement or personal preference rather than from any real shortcoming.

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**The Twelve Principles of Efficiency.** HARRINGTON EMERSON. (*Eng. Mag.*, xxxix, 3 etc.)—This series of articles on business organization is of the greatest interest to all business men and especially to the heads of large concerns. No abstract can give an adequate conception of its scope and tendency, but its perusal will cause every man to "stop and think."

**Modern Methods of Lightning Protection.** CHAS. P. STEINMETZ. (*Eng. Mag.*, xxxix, 4.)—An article of importance to those connected with institutions using electricity and especially those generating electricity. "The requirements of the lightning arrester are, that it affords a path from the line to ground at moderate overvoltage, that this path be of unlimited discharge capacity, that is afford no appreciable resistance or inductance to the discharge, and that the discharge shall not result in any disturbance of the system, which might cause high voltages and thereby damage, elsewhere, and should not produce a short circuit on the system."

**Blauwater-Gas and Carburetted Water-Gas.** J. VAN ROSSUM DU CHATTEL. (*Gas Lighting*, cxi, 511.)—Two plants of the same capacity, one making each kind of gas, have worked for four years in Amsterdam. The cost of carburetted water-gas is only five-sixths the cost of Blauwater-gas. About 25 to 30 per cent. of Blauwater-gas is mixed with the coal-gas and the mixture carburetted with petroleum benzine of 0.74 sp. gr. It has been found that a considerable quantity of the benzine falls out in the mains, both in summer and winter.

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The Chemist's Pocket Manual. A practical handbook containing tables, formulas, calculations, information, physical and analytical methods for the use of chemists, chemical engineers, assayers, metallurgists, manufacturers, and students. By Richard K. Meade, M.S. Second edition. 443 pages, illustrations, 16mo. Easton, Pa., The Chemical Publishing Co., 1910. Price $3.00.

North Carolina Geological and Economic Survey. Economic Paper No. 20. Wood-using industries of North Carolina. By Roger E. Simmons. Raleigh, State Printers, 1910.

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National Association of Cotton Manufacturers. Advance copies of papers to be presented at meetings. 12 pamphlets, illustrations, portrait, 8vo. Boston, Association, 1910.

U. S. Hygienic Laboratory, Bulletin No. 67, June, 1910. The solubilities of the pharmacopœial organic acids and their salts. By Atherton Seidell. 98 pages, illustrations, 8vo. Washington, Treasury Department, 1910.

U. S. Coast and Geodetic Survey. Results of Observations made at the coast and geodetic survey magnetic observatory at Vieques, Porto Rico, 1905 and 1906. By Daniel L. Hazard, Computer, Division of Terrestrial Magnetism. 110 pages, 4to. Results of observations made at Baldwin, Kansas, 1905 and 1906. By Daniel L. Hazard, Computer, Division of Terrestrial Magnetism. 107 pages, 4to. Washington, Department of Commerce and Labor, 1910.

Michigan College of Mines. Graduates, June, 1910. 118 pages, 12mo. Year-book, 1909-1910. 134 pages, 12mo. Views of the College, narrow 16mo. Houghton, Michigan. Published by the college, 1910.

Russian Turkestan and its Products. By N. J. Malahowski, Ph.D. 11 pages, illustrations, map, 8vo. St. Petersburg, "Journal of Finance," 1910.

Link-Belt Company. The Peck carrier, patented December 25, 1900, for coal, coke, ashes, cement, sand, stone, ore, and other materials. Book No. 81. 96 pages, illustrations, 8vo. Philadelphia, Link-Belt Company, 1910.

# CURRENT TOPICS

**The Menne-Oxygen Melting Process.** (*Iron Age*, lxxxvi, 8.)—The equipment included in contracts for the use of the Menne process does not cover the tanks of oxygen and coal gas. These are furnished by the Linde Air Products Co. When the tanks are owned by the furnace company the cost of oxygen and coal gas is about 2 cents per cubic foot, much less than when the process was first demonstrated in the U. S. Experience has shown that two tanks of oxygen and one of coal gas will open a frozen tap-hole, cinder notch or tuyere in a few minutes. Two men are necessary to operate the apparatus.

**Koenig's Theory of Ripple Formation in Kundt's Tube.** J. ROBINSON. (*Phil. Mag.*, xix, 476.)—Referring to previous experiments which were in fair agreement with Koenig's theory as to the ripple formation, the author now develops the theory by extending it to the case in which the velocities concerned are different, $w_1$ and $w_2$, instead of being identical, $w_0$. It is then shown that the change in the result is simply the substitution of $w_1$, $w_2$ for $w_0^2$. Comparing this theory with the experimental results gives a good quantitative agreement.

**Production of Natural Gas.** H. A. DANNE. (*Met. and Chem. Eng.*, viii, 412.)—The entire output of natural gas in the West Virginia oil fields is estimated at 1300 million cub. ft. per day, of which about 300 million cub. ft. are wasted. The thermal efficiency may attain as much as 1134 B. T. U. per cub. foot, but after compression of the gas it falls to about 900 B. T. U. owing to the deposition of liquefied hydrocarbons. It is employed for power purposes, zinc smelting, and the manufacture of glass, bricks, pottery, electrodes and lamp-black. Judging from the fact that the oil and gas are accompanied by coal and salt water, and that the pressure of the gas is nearly always affected by seismic disturbances, the author considers that these hydrocarbons are generated from natural carbonaceous deposits, by the earth's interior heat brought into proximity to these deposits by seismic disturbances; that they are still being generated under enormous pressure, and that on the release of some of the pressure, and consequent changes in the temperature of the hydrocarbons, some of the constituents are deposited in the dips of the strata and in the pockets known as oil-bearing pools.

**Solubility of the rare Gases in Water.** A. V. AUTROPOFF. (*Proc. Roy. Soc., A.38*, 474.—The solubility of xenon, krypton, argon, neon and helium in water was determined at temperatures from 0° to 50°C. The solubility rises with the increase of the atomic weight. At 20°C. the solubilities are He 0.0138: Ne, 0.0147; Ar., 0.0379; Kr., 0.0670 and 0.0788 (the reason for this difference in values is not known), Xe, 0.1109. The solubility of xenon is greater than that of any other gas, which does not form a compound with the solvent. In the case of all the rare gases, there is a distinct minimum of solubility. The minimum for xenon and argon lies at 40°C; for krypton between 30° and 40°C; for helium at 10°C; and for neon probably at 0°C.

**Silicon Steel.** G. A. BISSET. NAVAL CONSTRUCTOR, U. S. N. (*Iron Age*, lxxxvi, 8.)—This article will well repay careful perusal, as it gives a careful resumé of tests to show its superiority over other kinds. Among other things it is stated that high silicon steel was largely used in the construction of the Mauretania and Lusitania, the requirements being,—ultimate tensile strength 74,000 to 85,000 pounds per square inch; elongation in 8 inches, 18 per cent. The U. S. naval requirements are: Minimum tensile strength and elongations of 60,000 pounds and 25 per cent.; and 75,000 pounds and 17 per cent. for medium steel. Manufacturers have found that the requirements for high tensile steel can be met much more readily by high silicon than by high carbon steel.

**Widmanstadten's Figures.** N. BELAIEW. (*Révue de Métall.*, vii, 510.)—In certain steels which had been cooled extremely slowly sections were found to show Widmanstädten's figures as clearly as many meteorites. The author considers that the first crystallization from a molten steel is octahedral iron, and that when the cooling is extremely slow these octahedra have time to assume the same orientation. During cooling after solidification, secondary crystallization sets in, and lamellæ are formed in four directions in the octahedron. According as the section taken is parallel to the face of the related cube, to the octahedron, to the dodecahedron, or at an angle with any one or all of these, the crossing of two sets of lamellæ at right angles, of three sets at 60°, or of different systems, both cut at an angle is seen, and this it is which constitutes Widmanstädten's figures. These figures therefore are not peculiar to nickel-iron alloys, but should also appear in carbon steels, the behavior of which on cooling is generally similar to that of the nickel alloys. Osmond has observed a similar structure in Swedish iron, very slowly cooled, and martensite is probably a case of the same structure, of very small dimensions, and modified by the various orientation of the original octahedra. Such a strucure is characteristic of overheated steels, and is dangerous from a mechanical point of view.

**Sodium Carbonate as an Oxidizer.** E. DEISS. (*Chem. Zeit.*, xxxiv, 781.)—When finely divided silicon, tungsten, molybdenum, titanium, or such alloys as ferrotitanium, ferrosilicon, phosphor-iron, etc., are strongly heated with sodium carbonate, the metal becomes oxidized and carbon monoxide is evolved. This is found to offer a convenient method of attacking many metals and alloys which are dissolved only with difficulty by acids. The addition of magnesium oxide to the sodium carbonate renders it more effective, especially for chromium and its alloys, and prevents fusion of the mass. The carbon monoxide is allowed to burn as evolved, in order to avoid the possibility of reverse action.

**Leaning Tower of Pisa.** (*Eng. Record*, lxii, 6.)—According to the findings of a Royal Commission appointed to investigate the present condition of this tower, instead of being supported on a massive foundation, it rests on a ring-shaped masonry base, with an inner diameter of 24 ft. 3½ in., exactly the same as the inside diameter of the tower. The tower is about 177 ft. high, and in 1829 is said to have been 14 ft. 5 in. out of plumb; since that time its inclination has been increased by an additional 0.0055 ft. per foot of its height. In 1834 an earthquake caused a deflection of about 5 inches.

**The World's Production of Coal in 1908.** PROF. R. A. S. REDMAYNE. (*Iron Age*, lxxxvi, 9.)—The total world's product was about 1068 million tons:

| | Million tons |
|---|---|
| Great Britain and her colonies produced | 306 |
| United States of America produced | 377 |
| Germany produced | 215 |
| These three countries produced | 898 |
| Leaving for the rest of the world | 170 |

**Principles of Running Balance.** (*Amer. Mach.*, xxxiii, 32.)—An instructive and carefully prepared article, well worth the attention of machinists. Its contents are summarized as follows:

All rotating parts of high-speed machinery should be running balanced. A part in running balance will also be in standing balance. A part in perfect standing balance may be very far from being in running balance. The operation of standing balancing may be a detriment rather than a benefit to high-speed machine parts. A part in running balance at one speed will be in running balance at all other speeds, providing it does not distort from centrifugal action. Exact symmetry of form is no guarantee of running balance. High-speed parts should be so designed that they will not distort if rotated free at any speed at which they may run in use, and thus destroy a condition of running balance.

**Absorption of Iodine by Solid Substances.** M. GUICHARD. (*Comptes rendus*, cli, 236.)—Silica, both natural and calcined; alumina, calcined at 600°C.; magnesia, calcined at 1025°C.; and glucina all absorb iodine in quantities inversely proportionate to the degree of calcination. The differences in absorption are due to the shrinkages of the interspaces between the particles, and the cessation of absorption probably marks the disappearance of these interspaces and corresponds with the maximum density of the substance.

**Chemical Standards for Iron Castings.** JOHN J. PORTER. (*Amer. Mach.*, xxxiii, 32.)—This article will repay careful perusal. It may be summarized as below.

Cast-iron treated as an alloy, and the effect of the various ingredients present in the metal, or used in making the required mixtures. The physical properties of the metal and its behavior at different temperatures. The classification of castings, and the chemical composition of iron castings as used for various purposes; with a suggestion as to the best mixture to use for numerous purposes to which iron castings are put.

**Design of Centrifugal Pumps.** A. BORSODY. (*Amer. Mach.*, xxxiii, 39.)—This paper deals with the losses occurring in centrifugal pumps, their analysis and steps taken to reduce them. The principal losses in centrifugal pumps are well recognized, and by careful analysis they can be separated and the design regulated so as to produce the highest efficiency. For high heads, requiring high peripheral speeds, a diffusion-ring is employed, constituting a turbine pump. The diffusion-ring contains passages which split up the water from the impeller into streams, gradually transforming its velocity into pressure and reducing the whirlpool losses in the casing. A special construction described for surrounding the impeller with air, instead of water, so as to cut down the side friction, which is one of the principal losses in a centrifugal pump.

These principal losses are:

1. Side friction of impellers—called the rotor friction.
2. Hydraulic friction losses in the stationary parts of the pump.
3. Losses in the whirlpool chamber and losses at the periphery of the impeller.

**Germicidal Value of Thymol.** E. W. SCHMIDT. (*Zeit. Phys. Chem.*, lxvii, 412.)—Thymol has been used as an antiseptic and disinfectant especially in physiological experiments on digestion. The author examines its value in this direction. Experiments were made with albumin, peptone, fibrin, organisms and enzymes in the presence of saturated thymol water. All experiments were made at a temperature of 25°C. which is the most favorable to putrefac-

tive organisms. No difference could be found in the digestive or putrefactive actions whether the experiment was made in the presence or absence of thymol. Hence the conclusion is that thymol has no power to inhibit bacterial growth and is of no value as an antiseptic or disinfectant.

**Action of Metallic Contacts on a Filings Coherer.** B. SZILARD. (*Comptes rendus,* cl, 1670.)—The author finds that a filings coherer is very much more sensitive when the end of the coherer (which is earthed in the usual arrangement) is connected to one terminal of an alternating-current system, the other alternating-current terminal being connected to earth. He finds that a coherer connected in this manner is affected when a metallic rod set up as sending antenna, is simply touched by a piece of metal held in the hand. This action is obtained over 150 cm. The contact between the two pieces of metal must be very light and between points. The metals brought into contact may be the same or may differ. The maximum distance at which the effect is obtained depends upon the metals used.

**Carbonization of Rubber by Mercury Vapor.** W. VON BOLTON. (*Zeit. Elektrochem.,* xvi, 667.)—Mercury vapor decomposes volatile hydrocarbons, chloroform, carbon tetrachloride, carbon bisulphide, carbon dioxide and hydrogen sulphide with separation of carbon or sulphur. This reaction does not occur with liquid mercury, even at boiling temperature, but only by the monatomic vapor. Amalgams seem to produce the vapor more rapidly than pure metal, probably on account of their larger surface, but the action is noticeable in presence of mercury heated to 100°C. for about three weeks. Sulphur accelerates the action, selenium and tellurium retard it. Traces of moisture are requisite. If mercury vapor attacks pure non-vulcanized rubber, no carbon is separated but the rubber becomes hard and brittle and traces of mercury can be found in it. The carbon separated in ordinary experiments is found to contain small microscopic crystals of diamond.

**The Inventor of the Black-Ash Furnace.** W. RAMSAY. (*Chem. News,* cii, 69.)—In the correspondence of Dr. Joseph Black a letter to him from a Mr. George Golder was found, bearing the date of March 19, 1782, advising Dr. Black that Mr. Golder was sending him a sample of ashes made by Messrs. Collison and Co., London, with a copy of Collison's specification for making mineral and vegetable alkali, by the use of a reverberatory furnace. Dr. Black examined the ash and found it about 50 per cent. stronger than the best Alicant barilla, and about seven times the strength of kelp. The patent granted to Le Blanc for the process of manufacturing sodium carbonate and sodium hydrate was dated Sept. 23, 1791, and is therefore nine years later than Collison's patent.

**Ultramarine.** J. HOFFMANN. (*Chem. Zeit.*, xxxiv, 821.)—On consideration of the numerous investigations of this product the author concludes that the homogeneous character of ultramarine and the fact that changes in the constituent oxides are often unaccompanied by any essential alteration in color, are best explained by regarding it as a dilute solid solution containing besides alumina, boric anhydride, silica, and oxides of sulphur, dissociation products of thiosulphates, and probably sulphur itself.

**New Phosphate Deposits.** (*Board of Trade Jour.*, Aug. 25, 1910.)—An important find of phosphate deposits has been made at Safage, about 260 miles from Suez, on the western coast of the Red Sea. This deposit has been carefully examined and work will soon commence.

**Examination of Steels by Corrosion.** M. F. CLOUP. (*Rev. de Métall.*, vii, 605.)—A method is described for the examination of manufactured steel (forgings, etc.) in which the polished metal surface is treated either with a 4 per cent. solution of picric acid in absolute alcohol, or, as a less active reagent, with an iodine solution of 10 parts of iodine and 20 of potassium iodide, in 100 of water. By the action of the solvent, the lines of flow induced in the metal by the mechanical treatment become visible to the naked eye; and thus it is possible to discover the method used for the manufacture of the piece under examination. The effects due to mechanical treatment are generally easily distinguishable from initial defects in the metal and from changes induced by heating; in doubtful cases the microscope can be used.

**Hemlock Extract and Sulphite Liquor.** (*U. S. Consular Report*, July, 1910.)—The U. S. Consular Agent at New Castle, New Brunswick, reports that at a factory making hemlock-bark extract, the important discovery has been made that the residual liquor from sulphite pulp mills acts on the extract of hemlock bark, producing a larger percentage of tannin. This discovery has greatly aided the industry of producing extract of hemlock bark.

**Influence of the Size of Ingots on Segregation.** H. M. HOWE. (*Trans. Amer. Inst. Min. Eng.*, xl, 644.)—The larger the size of the ingot the greater the degree of segregation. The effect of increase of size on segregation is relatively slight until the thickness of the ingot is about 20 inches; with further increase of size the degree of segregation rapidly rises. The segregation of sulphur is greater than that of phosphorus, and that of phosphorus is greater than that of carbon. Marked segregation may take place even in small ingots. A small ingot, 5 in. long and fifteen-sixteenths of an inch in its widest part, of acid open-hearth steel, was quenched in water from a moderate red-heat. The outer portion of the ingot

contained 1.08 per cent. of carbon, but microphotographs of the metal around a small cavity in the upper part of the axis of the ingot showed that some of the metal had been converted into white cast-iron (about 3 per cent. of carbon) whilst the eutectic areas must have contained more than 4.3 per cent. of carbon.

**Prevention of Corrosion of Iron and Steel.** G. W. THOMPSON. (*Amer. Inst. Chem. Eng.*, 1910.)—Corrosion is best prevented by applying successive coatings of paint to the clean metal surface. The pigments should contain no hygroscopic nor water-soluble matter, nor substances capable (by reduction) of acting as depolarizers, and as far as possible should be non-conductors of electricity and inhibitors of corrosion. The use of linseed oil as a priming coat is condemned. The metal should be thoroughly cleansed before the application of the paint.

**Aluminum Nitride.** D. WOLK. (*Comptes rend.*, cli, 318.)—When aluminum powder is heated in the products of decomposition of gaseous ammonia, the nitride is formed at a temperature of 820°–850°C. The production is very rapid at 1000°, but above 1100°C. the product crumbles and begins to dissociate. The nitride contains 33.6 per cent. of aluminum (the compound $Al_2N_2$ contains 34.00 per cent.), and forms a gray mass. The lower the temperature of its formation the more readily it decomposes in water. Apparently no intermediate amide is formed.

**Nitrate Deposits of Southern California.** F. W. GRAEFF. (*Eng. and Min. J.*, xc, 173.)—These deposits are in the Chemehuvis Valley, 33 miles south of Needles, Cal. The bed is covered with clay overlaid with gravel, except where the clay has been denuded on the hills, which are from 100 to 300 ft. high. The nitrate is mainly contained in the clay strata, the content varies from 7 to 22 per cent. sodium nitrate together with sodium chloride, sodium sulphate and calcium sulphate. The overburden is soft and blasting is unnecessary. The Colorado River supplies the water requisite for extracting the nitrate.

**Progress in the Ceramic Industry.** W. PUKALL (*Ber.*, xliii, 2078.)—An account is given of the development and present condition of the ceramic industry. Some highly interesting experiments on the chemistry of the silicates are described.

**The Prevention of Power Monopoly.** H. KNOX SMITH. (*Eng. Record*, lxii, 11.)—A well considered article on the best method for the Federal Government to control the monopoly of water-power sites before private rights accrue. Eight main points are given which the controlling authority should bear in mind when granting water-power privileges.

**A Cobalt-Chromium Alloy.** ELWOOD HAYNES. (*Iron Age*, lxxxvi, 9.)—The first experiments were undertaken by Mr. Haynes in 1895 towards the production of alloys of nickel with iron, chromium and other metals. In 1905 some of these were repeated with a view to utilizing the alloys of cobalt and nickel with chromium for ignition-points in gas engines. The final product was an alloy containing 75 per cent. cobalt and 25 per cent. chromium, which could be hammered into thin sheets at a bright red heat without cracking. This alloy has an elastic limit of 79,000 lbs., a tensile strength of 96,000 lbs., and an elongation of 3 per cent. By reducing the quantity of chromium and adding other metals alloys are said to have been produced which are proof against nitric acid and sufficiently malleable to be worked cold. Other combinations have produced alloys which would scratch quartz crystal. The most remarkable property of a combination of 3 parts cobalt and 1 of chromium is its resistance to corrosion.

**Alcohol from Sulphite Cellulose Waste Lyes.** C. G. SCHWALBE. (*Zeit. Angew. Chem.*, xxiii, 1537.)—Wallin, at Forss, neutralizes the crude acid lyes with lime. Ekström, at Skutskär, Sweden, uses the waste causticization-sludge from sulphite cellulose mills; after neutralization the lyes are cooled and aerated in towers. It is said that the neutralization-sludge if used to prepare fresh lyes contains sufficient calcium sulphide to save 40 to 45 per cent. of the sulphur required. A yeast nutrient, malt-extract, or dead yeast is added to the neutralized, cooled and aerated liquid, and fermentation is set up. After fermentation and separation of the yeast the lye is distilled. This alcohol is obtained denatured as it contains considerable proportions of methyl alcohol, aldehydes, furfural and probably acetone. The yield is about 60 litres per ton of cellulose, or 50,980 litres monthly.

**Reform in Specifications for Petroleum Products.** DR. ALBERT SOMMER. (*Eng. Record*, lxii, 6.)—This is an interesting and valuable paper for consumers of petroleum products, and will repay careful perusal. Dr. Sommer points out that present specifications usually cover gravity, flash-point and burning-point, cold-test and sometimes color-test, but that these tests do not determine the value of an oil in practical use and at best are only descriptive. He recommends as the basic principles for tests which will indicate the practical value of an oil (say for the automobile user or gas maker) as (1) heating the oil at a certain fixed temperature for a certain number of hours; (2) precipitating the asphalt formed in the same by means of petroleum ether or ether alcohol; (3) determining the so-called coke or tar value in the oils before and after heating by means of caustic soda and benzol; (4) determining change of fluidity by a quantitative method; (5) emulsion test of oil with water at various temperatures.

**Colloidal Barium Sulphate.** Y. KATO. (*Mem. Coll. Sci. and Eng.*, Kyoto, ii, 187.)—To a solution of barium acetate, prepared by diluting a gram-molecular aqueous solution with six times its volume of alcohol, was added an alcoholic solution of sulphuric acid, prepared by diluting a molecular aqueous solution with twice its volume of alcohol. The milky solution and jelly-like precipitate thus obtained were evaporated to dryness, under reduced pressure, at a temperature below 40°C. Colloidal barium sulphate was thus obtained as a translucent, casein-like mass, readily soluble in water, the solution being fluorescent. The solution of the colloidal sulphate is, in general, coagulated by electrolytes; the coagulating power of different anions increases with their valency, according to Hardy's Law, and dissociating electrolytes have a higher coagulating power. Cations of high valency interfere with the coagulating action of anions.

**Testing the Hardness of Metals.** A. F. SHORE. (*Iron Age*, lxxxvi, 9.)—This is a highly interesting and valuable paper for automobile engineers and those interested in the hardness of metals. It is pointed out that there are many different kinds of hardness; viz., tensile hardness, cutting hardness, abrasive hardness, elastic hardness, static hardness, and shock hardness. According to Mr. Shore's view there is but one really important hardness, which may be defined as rigidity and resistance to penetration or deformation. Possibly this might be called tensile hardness.

**Measuring Aeroplane Altitudes.** AUGUSTUS POST. (*Amer. Mach.*, xxxiii, 35.)—To accurately determine the altitude reached when W. R. Brookins broke the world's record for height with an aeroplane at Atlantic City, a base line 2½ miles long was chosen. An engineer's transit was placed at each end of this base line with its telescope clamped in the vertical plane passing through the line, and by sighting upon the aeroplane as it passed above, the vertical angles at each end of this line were determined. Knowing the base and two angles of this triangle, the altitude was easily and accurately calculated. A recording barometer was used as a check. Full details are given in this interesting article. Also a description of a simple, but remarkably accurate method used by the Wrights for ascertaining altitude. Such measurements will be of the utmost importance in finding the range of an aeroplane in war time.

**Scandium.** SIR W. CROOKES. (*Phil. Trans. Roy. Soc.*, A209, 15.)—Scandium has been found to the extent of more than 1 per cent. in the mineral Wiikite from Finland, and in small amounts in many other minerals. By a systematic series of fractionations it is possible to separate scandium from most associated elements; ytterbium is the most difficult to separate because its nitrate is decomposed almost as readily as scandium nitrate. In view of the

atomic weight relationships, and of the frequency with which these elements occur together in nature, it is suggested that yttrium and scandium are degradation products of ytterbium. Scandium can be separated from yttrium and ytterbium by precipitation as meta-nitrobenzoate.

**Paper from Megasse.** CARMODY. (*Bull. Imp. Inst.*, viii, 151.)—Megasse is more suitable for paper making when it is mixed with other fibrous materials such as banana leaves and stems, maize residues, bamboo, sunflower or native grasses, etc. The best results are from a mixture of megasse, bamboo and Para grass. It is estimated that there are 50,000 tons of megasse available per annum in Trinidad. This would yield 40,000 tons of pulp worth at least one million dollars, or 30,000 tons of better quality pulp worth $1,800,000. If the megasse were mixed with bamboo and Para grass the pulp would be worth $2,250,000.

**Vanadium in Cast-Iron.** GEO. L. NORRIS. (*Iron Age*, lxxxvi, 5.)—Vanadium entered into practical metallurgy about 1903, when rich deposits of it were discovered in the Andes of Peru. Vanadium exerts a very powerful influence on steel. One or two tenths of 1 per cent. raise the elastic limit of mild carbon steel about 50 per cent. or more, without impairing the ductility, and vanadium steels have a very high dynamic strength. Vanadium cleanses the cast-iron from oxides and nitrides, eliminates porosity and produces sound castings. In chilled cast-iron vanadium produces a deeper, stronger chill, and one less liable to spall or flake. It greatly diminishes the wear on cast-iron cylinders. In malleable cast-iron the tensile strength is improved about 12 per cent.

**Action of CO and H, or $CO_2$ and H on Iron Oxides.** A. GAUTIER AND P. CLAUSMAN. (*Comptes rendus*, cli, 355.)—A mixture of 3 volumes of CO and 1 vol. H was passed at 300°C. over ferroso-ferric oxide. The product contained about 7 per cent. carbon, the remaining 93 per cent. being about one-half ferrous oxide and one-half iron carbide. When steam was passed over this at 400°C., a gas was obtained containing 96 per cent. H and 4 per cent. $CH_4$. If two volumes $CO_2$ and 1 volume H were passed over iron at 1250°C., the issuing gas consisted of 23 per cent. CO, 76 per cent. H and 0.15 per cent. $CH_4$. A mixture of equal volumes of CO and H, saturated with $H_2O$ vapor was passed over $Fe_2O_3$ at 250°–300°C. and the resulting gas was heated to 500° or 600°C. Besides permanent gases a small proportion of a substance, condensible to a jelly like solid, like vaseline, was obtained. These experiments may have a bearing on the geological formation of hydrocarbon gases and petroleum.

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